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POWER

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Blaze the Trail

THE writer of one of the responses to or comments upon my recent foreword upon "Relics" waxes indignant because the government or some other body does not gather up these examples of our industrial progress and preserve them.

Is not the trouble that things become obsolete before they become antique, and get simply out of style before they become ancient and interesting?

An old hat or bonnet hanging in a cobwebby attic may be interesting as an example of the costume of a century ago, or of sentimental significance as part of the intimate personal equipment of an ancestor.

But when it was hung up there, it had simply gone out of use, either by the passing of its owner or because it was no longer in vogue.

It was simply an old headpiece that had served its purpose and was ready to be discarded.

Any of the old hats that George Washington threw away would bring its weight in gold dollars now.

Nobody recognizes the historical value of these things until progress has built a setting into which they would fit most appropriately and their absence from which is apparent and regrettable.

And by that time they are irretrievably lost.

The owner of the first steam plant in America had no conception of its significance as the cornerstone of American Industry. It was only so much junk that was in the way and could be converted into cash.

We need museums and people with the museum sense, appreciation of the value of those features of the passing show that will be significant to future generations and illustrative of our manner of living and of the status of the arts in the different stages of our development.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

An Engineer in the White House

REGARDLESS of political affiliations, Mr. Hoover's election will gratify hosts of engineers, especially those who have long cherished the idea of members of the profession taking a more active part in public affairs.

Nevertheless, without discounting the effective work done by various groups of engineers in Mr. Hoover's behalf, his being an engineer can hardly be credited as a major factor in the tremendous vote cast for him. Rather, it appears to have been his record of accomplishment, his organizing ability and his method of analysis as applied to large problems—all predicated on an engineering training—that marked him for national leadership of a new order.

Since he is an exponent of minimum "government in business" and of co-operation between government and business to the end of rendering a maximum legitimate service to industry, the next four years will undoubtedly see wider application to all executive branches of those principles which have made the Department of Commerce such an aid to American Business.

Misleading Statements of Fact

TRUTH may be stated in such unfortunately chosen words that an incorrect impression is left in the mind of the hearer or reader. And this can happen entirely without intent on the part of the agency or person making the statement.

Undoubtedly, that is the reason that recent newspaper articles, based on a news release of the National Industrial Conference Board, tend to implant a wrong idea of the industrial power situation. The following statement is made:

> A significant change in the use of electric power for manufacturing, however, is noticeable in the growing trend toward increasing use of purchased current, that is, current supplied by central electric power stations, instead of the original method of generating the current in the establishment where it was to be used.

By completely ignoring the fact that this trend toward the purchase of power is only among those industries where generated power costs more than the central station can sell it for the reader is left with the idea that such a change is universal throughout the industry. Of course the power engineer well knows that where there is adequate use of process heat or other power-plant products besides electric current, the central station cannot now, and perhaps never can, compete with power made at the plant. But, unfortunately, the industrial executive does not always know this. So when he reads such statements as that quoted, and draws the wrong inference, as he almost always does, the road of power engineer to helping industry achieve the lowest possible power costs, is made much more difficult.

It is probably vain to hope that newspapers or other non-technical agencies can be induced to treat this subject in a more enlightened way. The only recourse open to the power engineer, if he would keep his profession at its present level of usefulness, is to preach continually by word of mouth or through the technical press, the way to true economy in the generation of industrial power.

Operating Methods that Save Money

MORE complete data on plant operation point the way to greater economy, lower production costs and consequently larger profits. Manufacturing costs are made up of many small items, such as power, heat, air, water, raw materials, labor, repairs and many others, including overhead. Most of these offer opportunities for large wastes if accurate information is not available on the quantities used and how they are utilized. In the main, this information can be obtained only by meters and other measuring devices. It is to this subject that the leading article in this issue is devoted.

Meter records are of no value if the information obtained is not analyzed and applied to bettering plant operating conditions. Meters are silent assistants, constantly on the alert to prevent needless waste. They proclaim errors in faulty operation and, if intelligently used, point the way to good management. The latter requires a careful analysis of the meter records.

Poorly managed plants may be divided into two general classes, those that lack metering equipment and those that have this equipment and make no use of it. Strange as it may seem, some of the most poorly managed plants are those that have the most complete metering equipment. It is also true that the best-managed plants are those whose adequate metering equipment is made effective by a management ever on the watch for opportunities to eliminate wasteful practices and improve operation.

The use of meters as a means of obtaining more efficient operation in power houses has been emphasized in the past, but what is true of the power house applies with equal force to the manufacturing processes, where the power services are used. Wastes in power services are not confined to the power house. They can be just as large in the processes where these services are used. Meters will not insure good management, but good industrial management without meters is unthinkable.

Smoke that Gets By

SMOKE abatement has long been under organized control in certain cities with varying degrees of success according to whether the remedial measures have been based upon systematic surveys and educational work or mere enforcement of an ordinance has been attempted. Of late, however, other sections, previously regarded as having no smoke problem, have become noticeably affected because of industrial growth, housing congestion or the introduction of smoky fuels. This has been productive of revived interest in smoke abatement.

Most smoke ordinances prohibit the emission of smoke denser than that corresponding to No. 3 Ringleman Chart for a given number of minutes, but in many instances it is the smoke light enough to get by, and persisting over long periods, that pollutes the air and is especially noticeable on days of high humidity. Moreover, it is not alone the soot-laden atmosphere that is obnoxious; the invisible pollution by acids and fumes is shown to be equally detrimental to materials, vegetation and health. Some of these are direct accompaniments of smoke, while others are independent of it.

Inasmuch as the average smoke ordinance is ineffective to cope with this phase of the situation, those cities that are just beginning to attack the smoke problem would do well to lay their plans on broad lines and vest their representatives with discretionary powers. A clearing house for information concerning the activities of various smoke departments and their methods of procedure would be most helpful.

Co-operation

IN A recent talk to McGraw-Hill Editors Julius Klein, Director of the Bureau of Foreign and Domestic Commerce, Department of Commerce, remarked that a German industrialist, while visiting this country, had commented upon the co-operation that exists among manufacturers. This co-operation, unheard of in Europe, the German felt to be a major factor in the industrial advance of this country.

What he said regarding industry is particularly true in the field of steam and electric generation. The freedom with which the electric utilities exchange operating experiences is well known and highly commendable. Unquestionably it is responsible for much of the improvement in plant design and operation. This co-operation has largely been carried on through the agency of organizations such as the A.S.M.E., A.I.E.E. and N.E.L.A., in whose journals and transactions the various operating experiences are published.

It cannot be said that the same degree of co-operation exists among the engineers who operate the smaller industrial power plants. If they would take advantage of the existing opportunities to exchange operating experiences through the various engineering societies in the same way that the utilities have, much might be accomplished to improve the status of the industrial power plant.

A Gold Brick Instead of Profits

INDUSTRIAL and power developments have been beset by many fads. There have been efficiency fads, power-equipment fads, alternating-current fads, meter fads, direct-connected motor fads and so on, without number. In fact, practically everything in the power field has been a fad at one time. So much so that engineers were prone to accept practices on what somebody had accomplished by them, rather than on a careful analysis of what might be expected under the conditions at hand. Such thinking often leads to unpleasant awakenings.

Industry in this country is entering upon a period of industrial research that promises tremendous possibilities. Already a great deal has been accomplished, so much that the imaginations of many are being fired with the achievements. But herein lies the danger of making it a fad and of attempting research without a carefully worked out plan of what is to be attempted, a clear conception of the kind of personnel required to do the work, the time necessary and the cost of the undertaking. Industrial research is more than hiring so-called research experts, providing a laboratory and paying the expenses.

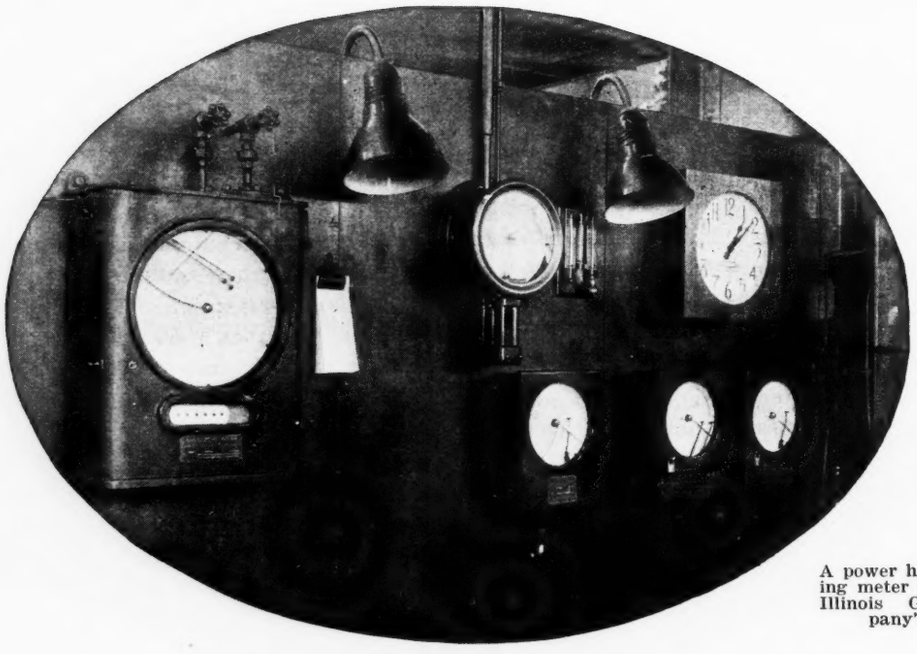
Industrial research, properly organized and carried on with a clear conception of what is involved, can be made profitable. However, this may involve many disappointments, even when properly organized, before profits are a reality. Many of the wonderful results that are being accomplished in our large industrial research laboratories today are the culmination of years of effort and large expense. Unless those attempting research programs enter on the projects with a comprehensive knowledge of what is involved and are willing to back the undertakings with time, effort and money, they are likely to find a gold brick where profits are supposed to grow.

Imagine the Savings!

IMAGINE what a difference it would make in the power costs of some industries if the control of power applications in the factory were as well carried out as is the control of power generation. Too often, the utmost care is taken to make power at the lowest possible cost and then this power is wasted in the plant through poor control.

Pressure, temperature, quantity, level, flow and time are all controlled by means of meters and hand control or through automatic devices. The production man is aware of this, but often has not the time, knowledge or technical skill to put it into effect. The power engineer, on the other hand, lives with such control daily in his power house and is, therefore, eminently fitted to establish it throughout the plant.

Unfortunately, the management in the plants where wastes occur does not realize how much saving the power engineer can make. But when the competition of the many plants that do use these controls effectively brings this lesson home, and management puts the control of power used in the factory squarely up to the power engineer, imagine the savings that will be made!



A power house recording meter panel in the Illinois Glass Company's plant

METERS
Essential to Good Management

By John W. Romig
Plant Engineer
Illinois Glass Company, Alton, Ill.

COST of production is the all-important keynote in industry in these times of ever increasing competition. The old law, "Survival of the fittest" applies to industry as it has applied to the history of mankind from the beginning. The manufacturer having the lowest cost per unit of production without sacrifice of quality of service, is well fitted for success in the given field. Methods followed today will be obsolete tomorrow; continual, unrelenting effort must be expended to keep abreast of competition.

It is because of keen competition that cost accounting has made such rapid strides in industry. Accounting provides the basis for determining what items manufactured are profitable and what are not; it gives information required for estimating prices to be quoted on prospective contracts, and in addition to this it provides detailed costs of manufacture necessary for proper analysis of individual costs.

The total cost of manufacturing an item is made up of many small costs. Often the individual small costs are seemingly unimportant, but in production work they amount to many dollars on a large contract. Among the items entering into the total cost pro-rated over the production units are: Direct and indirect labor, raw and finished material, repairs and maintenance, depreciation, taxes, interest, supervision, sales, advertising and contingencies; last but not least, fuel, power and energy in one form or another.

While fuel, power and energy are not, as a rule the greatest contributors to total cost, they amount to a considerable item in practically all manufacturing. The useful assimilation of these essentials without waste, presents possibilities in keeping costs low. The determination of the quantities required for the various operations performed gives the accounting department truer costs and the development departments data for comparison of systems and methods of applying energy to the manufacturing processes in the most economical form.

In order to secure energy input for a certain operation or department, a means of measurement must be provided. Metering equipment is rather expensive from the viewpoint of first cost, but in most cases a meter installation will pay for itself during the first year. The time of paying out is contingent upon the consuming unit, the metering of services that are of sufficient size to permit an appreciable saving and upon adequate supervision to make sure that the information secured is properly used.

An instance of the use of meters is where, on overtime work, about $40 a day was saved by operating a motor-driven vacuum pump instead of a steam-driven unit used in normal daily production. This saving was sufficient to show a profit on a contract that otherwise would have shown a loss, by supplying the vacuum by a motor-driven vacuum pump.

Electric meters showing power consumed during an

operation will give operating data essential where maximum demand charges are made. In one case, by a study of maximum demand for power and how this was affected by plant operation, it was possible to make changes in operating procedure that saved as high as $1,000 a month in power costs.

Of course meters without analysis of their records are of no value. It is the combination of the record and its analysis that brings results. Wasteful operation, carelessness in the use of energy, can be checked readily with metering equipment. One shift may be wasteful or be less competent, one group of operators or attendants may be careless. These are often unseen losses when meters are not used. Steam traps frequently are piped so that their operation cannot be judged externally. A meter on a departmental main will show the use of steam when the machines are out of service. In one case several traps were in bad condition and the steam cost per hour for steam wasted was 60 cents. By the use of a meter the loss was found. It is interesting that no one remembered when the traps had been given a thorough overhauling, so it is possible that the loss amounted to many hundred dollars.

A manufacturer buys so much fuel, or energy. In these days he should do more than pass the invoices, resigned to the apparent fact that the bills rendered are high. He should know where and in what quantities the commodity he is paying for is being consumed. He should have information at hand whereby the demands of the major consuming departments can be totaled and compared with previous performances. Such information leads to the adoption of more economical processes, the elimination of wastes and the distribution of energy cost direct over the production unit. It is agreed that overhead costs should include only such items as cannot be applied directly for accurate cost records, and the measurement of services is a step forward in direct cost application.

The installation of tanks of known volume to receive shipments of liquid fuels affords a check against bills of lading, accurate scales allow the checking of weights of coal or of other commodities. While vendors, as a rule, are honest, it is desirable for them to know that errors or carelessness on their part will not pass unnoticed. The practice of checking inbound shipments is sound and is good business procedure.

Liquid meters are not entirely satisfactory for heavy fuel oils or viscous liquids, so tanks of known capacity with gage marks, a gage stick or a floating gage provide the best means of checking shipments of liquids. It is good practice to have the receiving clerk observe the levels in the receiving tank before and after receiving a consignment. In some cases a liquid is loaded at a higher temperature than the receiving temperature, in which case a temperature correction for shrinkage is in order.

In the purchase of electrical energy, water and fuel gas, payment for the commodity is made on metered quantities and it is extremely important to have accurate metering equipment. Metering equipment is usually furnished for electrical energy, water and fuel gas by the vendors, who, as a rule, assume the responsibility of checking for the accuracy of the meters. Such checks should be made in the presence of representatives from each interest concerned and a record of the check and any adjustments made kept for reference.

If a meter has an error of plus one per cent and the monthly cost of the item metered is $10,000, a payment of $100 in excess of the correct amount must be made. It is therefore advisable practice to insist upon checks at least once a month, to keep the meter calibration correct. Where considerable sums of money are involved, it is a safeguard to install check meters, and when a discrepancy in readings is found, checks can be made immediately and errors corrected. When meter readings are taken for billing purposes, they should be made jointly by a representative of the purchaser and a representative of the vendor, so that possible complications due to taking readings at different times may be avoided.

Quantities are not the only point to consider in receiving materials. The weight may be correct, but is the quality according to specifications? Coal may contain

The Author Says

THE advantages of weighing and metering devices in an industrial plant may be summarized as follows:

1. Reasonably accurate data are secured for making decisions on more economical equipment.

2. Comparisons of fuel grades for maximum economy can be made intelligently.

3. Interest in maintaining economical practices is stimulated.

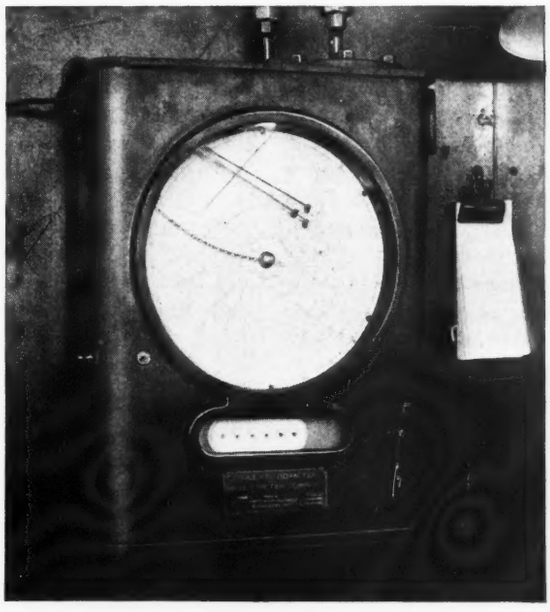
4. Practices not economical are easily detected.

5. Costs of operation can be more closely applied to the unit produced.

6. Comparisons of designs of equipment for economy can be made and designs to gain this end can be adopted.

7. Records of actual energy quantities are available for use in designing new distribution lines, pipe lines, plant additions, etc.

8. Metering equipment changes operation from a slipshod and perhaps careless use of energy and materials to a sound basis.



Meter measuring steam flow to 1,000-kw. turbine

10,000 or 12,000 heat units per pound as received, and a ton from one car may be worth only ten-twelfths that from another car. Occasional checks of the fuel analysis, whether coal or coke or fuel oil, gains a vendor's respect and has a steadying effect on quality. If fuel gas is being purchased in quantities, the heat content should be checked or a recording instrument used if laboratory checks show considerable variation in heat content. Air dilution in fuel gas due to leaks on suction lines to gas compressors will not be discovered if the heat content is not known. Such a condition may go on for months if not discovered, and a direct loss result.

While the quality of electrical energy will not be challenged, it is advisable, if the purchase of alternating current is made on a power-factor schedule, to have records of voltage. Wide voltage fluctuations have distinct effects upon the power factor of a plant, and a recording voltmeter is a good investment. Placing a similar instrument on plant transmission lines of doubtful capacity will lead in some cases to alterations whereby a better power factor and improved operation will result. If direct current is purchased, a recording voltmeter will show any fluctuations that would have a definite bearing on direct-current equipment speed and performance. Occasional checks on transmission lines are advisable under normal operation, as low or high voltages are undesirable. Low voltages cause excessive line losses and high voltages cause coil failures and other troubles that interfere with continuous operation of power and production equipment.

Measuring equipment aids in determining the value of a commodity. It serves in tests to determine the value of a service purchased and will show whether the cheapest in first cost is the cheapest in the end. Tests under actual operating conditions are advisable for selecting the quality and price combination giving maximum economy.

> **A manufacturer buys so much fuel, or energy. He should do more than pass the invoices, resigned to the apparent fact that the bills rendered are high. He should know where and in what quantities the commodity he is paying for is being consumed. He should have information at hand whereby the demands of the major consuming departments can be totaled and compared with previous performances.**

In the preceding paragraphs some thoughts on the receiving of energy have been covered. Once the energy is received, it is desirable to find out where it is going and in what quantities, in order to charge production and to check operating excesses or economies. Once the energy is transmitted to a department in a plant, the initial cost can no longer be applied. The costs of transformation and transmission must be added to the unit purchased cost to make a unit cost as used. The energy forms referred to include coal, coke, fuel oil, fuel gas, electricity and water.

It is essential, in getting at the individual costs of service, to determine the energy quantities used in the production departments. The first step in studying the problem is to outline the services provided in the individual plant. This can be done by making line diagrams indicating each source and each of the consuming units.

An industrial plant may use all the energy forms mentioned, so the distribution of each will be discussed. Almost every plant is equipped with steam generating equipment, and this energy branch will be used for a starting point. When coal or coke is used as fuel for steam generation, the weight of fuel to each generating unit gives valuable operating information when the output of the unit is measured. Measuring devices for coal, it may be stated here, are, at best, a makeshift and weighing equipment is the most reliable.

One of the most accurate equipments for measuring the total steam generated over a period of time, say a month, is the feed-water meter, equipped with indicating, recording and integrating mechanisms. The quantity integrated by this meter may be corrected for blowdown which, as an average, amounts to about 2 to 4 per cent of the total water fed to the boilers, depending upon feed-water conditions. Having the total number of pounds of water fed to the boilers and the total cost of boiler room operation for a given period, the cost per thousand pounds of steam can be easily calculated.

A good method of operation to follow is to measure or weigh the fuel used each shift and from the feed-water meter calculate for each shift the number of pounds of water evaporated per pound of coal. A record should be kept of blowing down the boiler, as a fireman could make his operation look better than it really is by blowing down excessively. A steam meter giving the total quantity of steam generated is of value in making calculations for operating costs and for making operating decisions. However, if each boiler is provided with a steam-flow meter, the results can be checked with a fair degree of accuracy and each boiler's performance obtained.

Two divisions of steam cost are useful—first, the fixed cost per thousand pounds, and second, the variable cost per thousand pounds. It is on the variable costs that calculations for different methods of operation should be made, as these costs represent money actually spent from day to day for meeting operating expenses such as labor, fuel, repairs, water, power, etc.

An analysis of boiler-room costs and efficiencies will show just which items are out of proportion, and inefficient practices or equipment may be given prompt attention. If an industrial boiler room shows an efficiency of less than 67 per cent, no further evidence is needed to show that something needs attention. Meters enable the management to make decisions that lead to more profitable operation.

Once the steam is generated, it is distributed to the various users, boiler-room auxiliaries, turbine-generators, compressors, process work, heating system and pumps or other equipment. Integrating and recording meters are desirable for each user requiring more than $1,000 worth of steam per year. A portable check meter will give reasonable accuracy in checking, at a low cost, the consumption of smaller users and a rate of consumption under average and maximum steam-flow conditions.

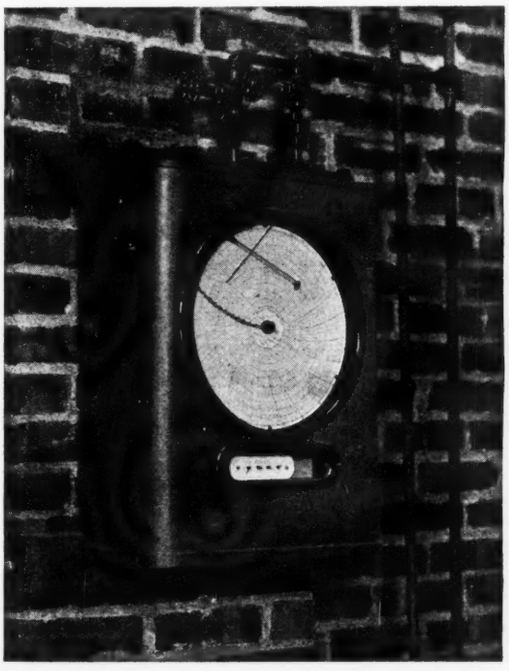
Some doubt as to the advisability of making expen-

sive steam-flow meter installations may arise, as the cost of this equipment is rather high. However, if a department head knows that he is receiving and paying for the steam supplied as shown by a meter, a far greater interest is taken in its economical use than if a set charge were applied monthly as an overhead item beyond his control. If the steam consumption increases, because of faulty operation, traps, or relief valves out of repair or changes in operation, the department head has an incentive to make corrections. A further advantage of metering equipment is that the records allow a proper cost charge to be set on the operation on an hourly or production-unit basis.

Meters should be installed on the prime movers of electric generating equipment on the line supplying each unit and its auxiliaries in order that the cost per unit of electrical energy may be determined. A comparison of the actual cost with possible purchased power costs may furnish reason for changes in operating policies. Steam a totalizing meter on it to detect leaks and to check the demand. Major using units or departments should have water meters on the branch mains so that accurate distribution data can be secured.

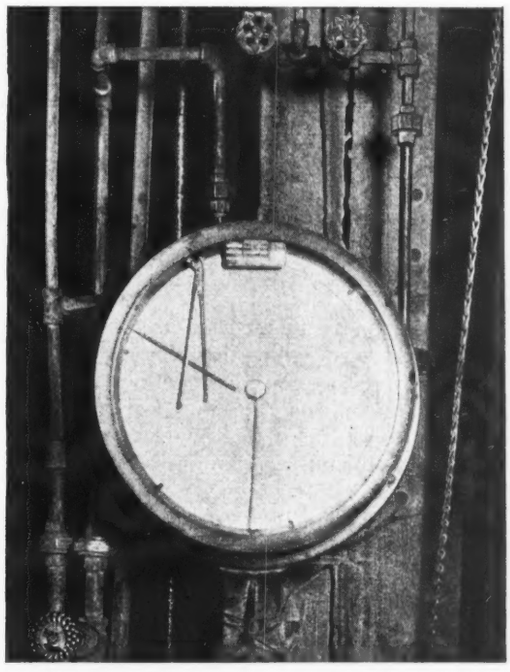
In the case of fuel oil or fuel gas, metering equipment is almost indispensable for economical results. Inefficient practices can be ascertained and corrected promptly and actual consumption figures for each unit charged directly to the unit. The records will show the more efficient units over periods of operation and will serve as basis of future design, as well as showing cases where a unit may not be adapted for use in manufacturing a particular product.

Electric watt-hour meters for electric driven units of 100 hp. or over, driving compressors, blowers, etc., and for departments or machines having an electric power cost of $500 a year or over, are valuable in securing proper electric power distribution data. A further advantage of this installation lies in the department super-



Left—Meter measuring total water flow to the plant. The water line should have a meter on it to detect leaks and as a check on the demand.

Right — Meter measuring oil gas flow to glass furnace. In the case of fuel oil or fuel gas, metering equipment is almost indispensable to economical results.



used for reciprocating units is rather difficult to measure without the installation of receivers; however, this is practical for determinations of flow and allows the comparing of operating costs on different units.

When the steam requirements and costs of operating compressors and other equipment are accurately known, comparisons of economies of new types of equipment on the market may show savings to be secured with new equipment. Unless the figures on energy consumption are available, equipment is frequently operated at a premium in operating cost until worn out.

Heating-system steam, if the high-pressure steam is used, should be metered and the distribution of cost made according to the amount of radiation in the various departments, all reduced to some standard. In case low-pressure exhaust or bled steam is used, the total heating-system charge is the increase of high-pressure steam consumption when the heating system is in operation, and the distribution of cost should be made in the same manner as with high-pressure steam.

Compressed air from air compressors can be metered to the principal users. The water system should have

intendent gaining interest in keeping his power bills low, and seeing that motive equipment not in active production is not kept in motion.

Because of the considerable expenditure involved in properly metering the equipment in an industrial plant, it is desirable to install equipment covering the largest users first, unless it is seen that a smaller user is extremely wasteful. A program should be mapped out whereby all main energy users will be eventually equipped with metering devices so that designs and layouts keeping this in mind may be followed.

The practice of using metering equipment on the main supply lines and on other parts of processes is becoming almost universal. However most industrial concerns of today are content to pay invoices and do not study the causes of their energy demands and what can be done toward reducing the costs. Just as the cost accounting systems have developed and as competition becomes keener, manufacturers must go deeper into the study of costs, and it is only a matter of a few years until practices along the lines discussed herein will be widely adopted.

SELECTING M

for Driving

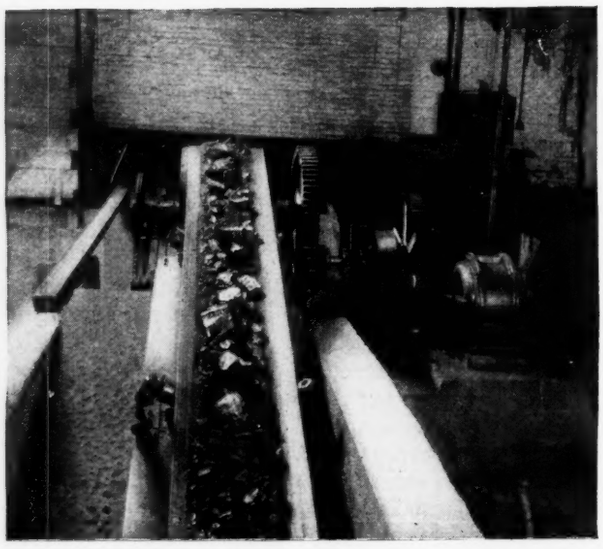


Fig. 1—Induction motor driving coal-handling belt conveyor, in gas plant

* * *

BOTH the squirrel-cage and slip-ring types of induction motors have been successfully used for driving conveyors. With the slip-ring motor it is possible for the operator to notch the controller around gradually and thus apply a gradually increasing pull on the conveyor belt until its static friction is overcome and starting is done with the minimum of shock to the equipment. Besides the ability to increase its torque gradually to a maximum at zero speed, the slip-ring motor has a low starting current as compared with that of the general-purpose squirrel-cage motor. For this reason many power companies insist that above certain sizes, slip-ring rather than squirrel-cage motors be used on their power lines.

However, because of its greater simplicity, lower first cost, higher efficiency and lower upkeep, the squirrel-cage motor is generally used for conveyor drives, particularly in the smaller sizes. For these reasons the squirrel-cage motor should be considered in every case where alternating current is available. When selecting a squirrel-cage motor, it should be remembered that there are a variety of types whose designs differ mainly in their starting torque and inrush current. Under some conditions, such as in cold weather when lubrication tends to congeal or freeze, it may require twice the torque to start the conveyor as for driving after it gets into operation and the lubrication has warmed up. Therefore, a squirrel-cage motor having a so-called double-wound rotor should be used.

With this type of motor the high-resistance winding comes into play when the motor starts, causing it to exert 200 per cent or more of its normal full-load torque. When full speed is reached, the high-resistance winding has practically no effect and the low-resistance winding carries the load. In this way high torque is obtained for breaking the static friction of the conveyor and getting it into motion.

Another desirable feature of this type of motor is that, when starting on its high-resistance winding, the starting or inrush current is much less than that required by a standard general-purpose squirrel-cage motor. This feature is a particularly good one, because the ordinary squirrel-cage motor sometimes draws so much current from the line at starting as to cause objectionable flickering of the lamps installed in the neighborhood on the lines.

If a general-purpose squirrel-cage motor is to be used for driving a conveyor, it is important that an oversize motor be selected. The general-purpose squirrel-cage motor with single rotor winding, as usually designed, can exert only about 125 per cent of its full-load torque when starting on full voltage. When started on the 80 per cent tap of a compensator, the starting torque will be reduced according to the square of the voltage, or $0.80^2 \times 125$ equals 80 per cent of full-load torque. For many conveyor installations this will be found to be insufficient and, consequently, a larger motor should be used which will have sufficient torque to start the conveyor under all conditions of operation. After the conveyor is up to speed, the motor will be considerably underloaded, with resulting poor power factor. This condition can be avoided by using either a slip-ring motor or a double squirrel-cage motor whose normal rating more nearly corresponds to the power required for driving the conveyor when loaded.

Practically all double squirrel-cage motors are designed for full-voltage starting. This does away with the neces-

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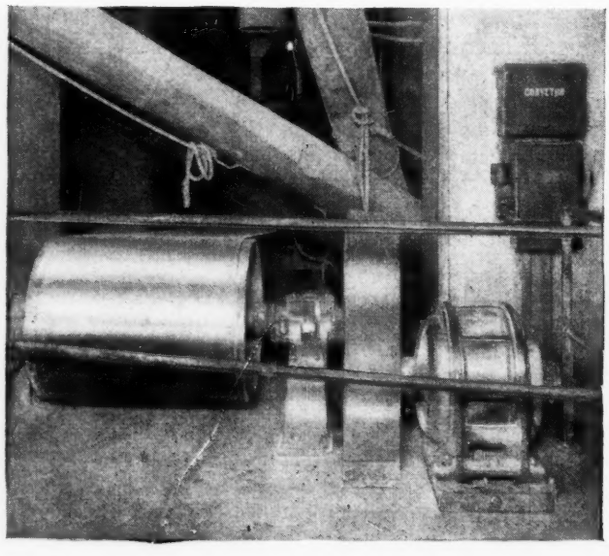
Fig. 2—Induction motor geared to belt conveyor in basement of grain elevator



MOTORS

Conveyors

By R. F. Emerson
Industrial Engineering Department
General Electric Company

sity of using a compensator or a resistance starter, with resulting reduction in cost. All that is required is a magnetic switch operated by a start-stop push-button station.

If a compensator or resistance starter is used, care should be taken to specify definite-time acceleration. With this type of acceleration the various accelerating contactors will close after predetermined intervals, irrespective of the load. There will also be no chance of locking out the motor with the starting resistance in circuit, because of the high static friction of the conveyor. Starting resistances or compensator coils are not designed to be in circuit continuously. If they are not removed from the circuit, they may burn out owing to the high starting currents.

Where direct-current motors are used for operating conveyors, there are three types to choose from—series, shunt, and compound wound. A series motor should never be used. If the conveyor is belted or chain driven, there is a chance the belt will come off or the chain break.

* * *

Fig. 3—Location and operation of main conveyor belts on coal-loading pier

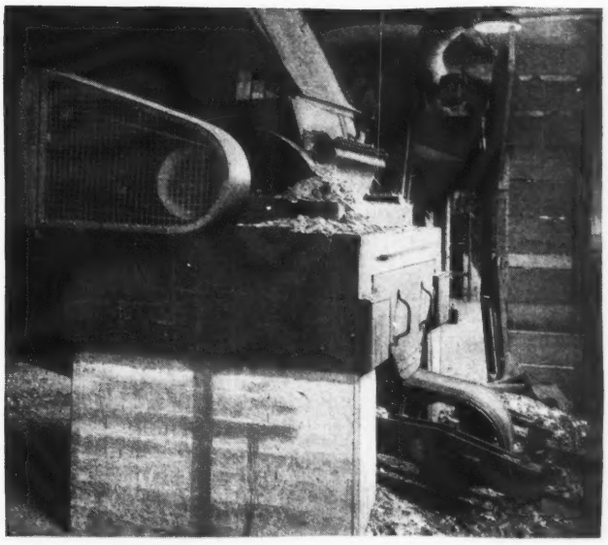


Fig. 4—Motor-driven belt conveyor in chip department of sulphite paper mill

* * *

If this should happen, the motor will overspeed and destroy itself. It is an inherent characteristic of the series motor to run away when its load is removed. The speed of a series motor varies with changes in the load, making it difficult to predetermine the speed of a belt conveyor driven by a series motor.

The shunt motor is a practically constant-speed machine, and any change in load on the conveyor will cause little change in speed. This type of motor can be used for conveyor drive. A shunt motor also is practically the only safe direct-current motor to use in the case of a retarding conveyor, where the load overhauls the motor, causing it to act as a generator to prevent overspeeding.

Compound Motors Used

Compound motors can also be successfully used for conveyor drive, but changes in load will make greater variations in speed than if shunt motors were used. If the conveyor is inclined and the load overhauls the motor, it is preferable to use a shunt rather than a compound motor, because the latter may tend to overspeed if the overhauling load is sufficiently great.

The control used with direct-current motors usually consists of resistance which is placed in series with the motor at starting. This resistance is cut out in one or more steps as the motor comes up to speed. If magnetic control is used, definite-time method of acceleration is preferred, to make sure that the motor will be ultimately connected across the line, as otherwise the resistance will burn out if left in circuit.

Inclined belt conveyors may be used for transporting material either up or down grade. For transporting up grade, motors and control can be used as previously outlined. If the weight of the material on the belt is sufficient to cause the belt to run in the reverse direction when the motor is disconnected from the line, it is advisable to equip the motor with a solenoid brake which will be applied when the motor is disconnected from the power supply and prevent the material from being spilled at the foot of the incline.

If the material is being transported down grade and the motor acts as a generator, thus braking the load, a

solenoid brake should also be used to prevent the material from being spilled at the foot of the incline. With a direct-current motor the brake should be shunt-wound rather than series-wound, because a series-wound brake will set should the motor change from motor to regenerative torque operation.

An induction motor used with a retarding conveyor needs no special protective devices except an overload relay to protect the motor against overloads and short circuits.

When using a direct-current motor, an additional protection is necessary to prevent the conveyor from overspeeding when power fails on the supply lines to the motor. Under this condition the motor, being driven as a shunt generator, continues to supply voltage to its own shunt field and to the shunt brake coil, thus holding the brake released, and it becomes necessary to use a centrifugal speed-limit device or an overvoltage relay. The contacts of either of these devices must be connected in series with the shunt brake circuit, so this circuit will be opened if either the speed or voltage becomes excessive. This allows the brake to set and stop the motor. An induction motor is not subject to this condition. If its supply lines are interrupted, it fails to generate any voltage and the brake sets immediately.

Magnetic Sequence Control

Magnetic control can be used advantageously in cases where a number of belt conveyors are operated in sequence. Standard devices can be used. When properly installed, the operator can press a button which starts the conveyor nearest to the point of delivery of the material being handled. When the magnetic switch closes to start the first motor, it automatically energizes the switch of the second motor, causing this conveyor to start. In this way a sequence of any number of conveyors can be started. In case of an objectionable overload on any one conveyor its magnetic switch opens and shuts down the motor. All the other motors ahead of it in the sequence also shut down immediately, preventing material from piling up, but the remaining motors after it in the sequence will continue to run and clear the conveyor system of the material being handled. This method can be used with either alternating- or direct-current motors.

Selling Your Old Machinery

By D. A. Hampson

WHEN one has a discarded machine on hand, it is best to sell it for what the prospective purchaser offers. Do not hold out for its book value. An instance that will strike home to many plant owners deals with the purchase of an old plant by a concern in an entirely different line of business. The original owners had supplied power to the several buildings of the group by rope drives from the power plant. A Corliss engine had done service for 30 years and was in excellent condition at the time the plant was sold.

The new owners occupied but one of the buildings and used comparatively little power. It was hoped to get other industries in the other buildings, but there was no intention of supplying power from the steam plant because of the radically changed knowledge as to the best way to drive scattered loads. At the time the property was sold, the firm of appraisers had set $2,500 as the worth of the engine to any buyer.

Soon after getting settled, the new owners began to hunt a buyer for that engine. Many prospects came to look it over and some made offers for it, while others were scared off by the price. The best offer received was $1,200, which really was good when the number of second-hand engines on the market was considered. The firm held out for not less than $2,000, and gradually the prospects faded out entirely.

Three years later the space was needed and efforts to sell were renewed, this time at $1,200. In a year there were only two nibbles. One of these offered $500, which was promptly refused, and the other was looking for a left-hand engine, whereas this was right-hand.

Two years more passed and the engine had to be moved out of the building, so a junk man was sent for. By that time the management had concluded that the engine would bring a pretty good price as junk. As a matter of fact, when the labor of dismantling had been deducted from the scrap price of the materials, they nearly owed the junk dealer some cash, for the difference amounted to but $20 in favor of the plant owners.

Poor judgment was shown all the way through. In the first place, the appraisers' figure was much too high, as a comparison with similar engines offered in the market would have shown. In a competitive, declining market, ordinary rules of valuation do not hold true. Machinery of all kinds is subject to obsolescence, which is nowadays about three times as rapid as physical depreciation.

Had this firm sold the engine for what a buyer would pay, it would have written off but half the inventory adjustment that it did ultimately. The interest on this money would have paid its light bill for the six years. Moreover, the space occupied by the engine and auxiliaries would have been a revenue producer over the same period.

As a general rule, when you have a white elephant, it does not pay to be finicky about the price. This engine was a white elephant from the start, because individual motors were the proposed source of power when the plant was bought. Any buyer should have been welcomed.

Outside of every engine room, machine shop and factory that has been going for 25 years, one will find machines or parts that fall in the white elephant class. "Somebody will come along to buy that" is the excuse made at the time the stuff was sidetracked. There it remains for years and years; rust robs it of any resale value in a short time and lowers its attraction as foundry scrap. If it had been sold on the minute, that same machine or part would have commanded the highest market price as heavy-machine scrap.

The writer knows of a plant that has an engine as bright as the day it was started. It is belted up to a three-cornered system that includes the water power that has not failed in ten years and a motor of equal size hooked up to city service. They have had offers for that engine (which they know they do not need), but none was high enough to suit. Meanwhile they are losing interest on the space and the investment and are paying a man to keep the engine wiped and polished. Some day it will go as junk.

The owners of an Eastern shipyard refused $8,000,000 in the dark days of 1920, but the plant has stood idle ever since and they would gladly accept $1,500,000 for their white elephant if a buyer would appear today. If you have a plant or an engine or a security that you don't want, sell it at once at the buyer's price.

Improved Flashboard Design

Increases Hydro Plant Capacity

By Joseph Jacobs

New design reduced the amount of board lost during floods, simplified replacement and increased the plant's output fifteen per cent.

At A certain hydro-electric development, completed in 1912 and designed for an effective head of 70 ft., the tailrace was not excavated to the extent called for in the original design. As a consequence the effective head was about 63 ft. only. As the load increased on the plant, it became necessary to consider using flashboards to raise the pond level.

The conventional type of flashboard was used, consisting of steel pins inserted in holes in the top of the dam. The boards were fastened to the pins by wire nails driven through the boards and bent around the pins. The $1\frac{5}{8}$-in. steel pins were sufficiently high for a three-foot flashboard and answered the purpose for a time.

This type of flashboard usually failed at about a six-foot head above the crest. Failure was by the pins bending downstream, which left a net height of flashboard of about eighteen inches. This proved objectionable because it took considerable time to draw the pond down preparatory to renewing the flashboards. Considerable expense was also involved for heating and straightening the steel pins. After a time repeated heating and straightening usually caused the pins to break, entailing additional expense for new ones.

New Type Flashboard Devised

Increasing demand for greater capacity made it necessary to devise an improved type of flashboard that would give greater operating head. In the event of failure it was desirable that the spillway be left clear so that the reservoir level could be controlled more readily for flashboard renewals.

As indicated in Fig. 1, the new type of flashboard consists of "A" frames, spaced twenty inches on centers. These frames are made of cheap sap, second growth pine. The upstream leg of the frame is braced against, but not fastened to, a 4x6-in. timber which is anchored to the top of the dam's crest and is continuous the full length of the 900-ft. spillway. The downstream leg of the frame rests in a pocket cut in the concrete. This pocket is the center about which the flashboard structure tends to revolve. Thus it can be seen why the anchor bolts fail in tension. The stress due to the impounded water is carried by the anchor and release bolts shown at the right in Fig. 1. This type of flashboard was designed to fail at a minimum head of 9.6 ft. above the crest. Up to that time the maximum flood stage on record was 13 ft. 6 in. above the crest, with no flashboards on the dam.

The "J" anchor bolts are home-made, out of junk material. The method of anchoring them consists of splitting the ends with a hot chisel and inserting the wedge piece, just enough to hold. Then the bolt and wedge were lowered into a hole in the dam's crest and driven down as far as possible, the wedge forcing the split ends to the side, thus solidly anchoring the bolt in the concrete. As a final precaution the holes were filled with grout. It was at first decided to purchase the $\frac{1}{2}$-in. release bolts ready for use. Later they were purchased blank, and the threading was done at odd periods.

The calculations were carefully worked out, as shown by the flashboards failing at heads varying between nine and ten feet. When the failure occurs, the 1x12-in. boards together with the "A" frames and release bolts are carried away, leaving the spillway clean. This does not mean that the entire 900 ft. is swept away, because there is always some one weak spot that fails first. We sometimes lose 50 ft. of the flashboard, and then again it may be as high as 200 ft., all depending upon the condition of the flood in the river.

To minimize the extent of the failures, 1x12-in. boards of the same length are used and nailed one above the other with their ends in line; that is, along the center line of the same upright. In this way a section equal to the length of the boards can fail and leave the crest without

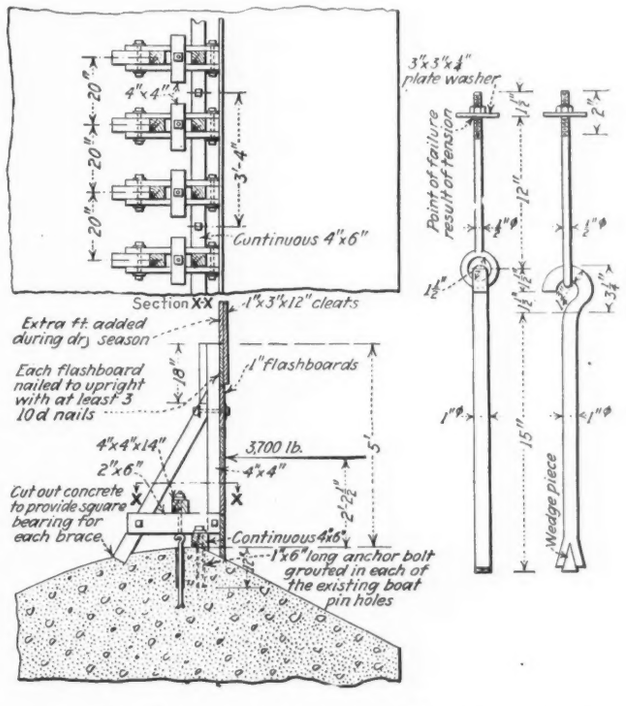


Fig. 1—Details of the improved flashboard construction

much tendency to pull the adjoining section with it. The boards terminating on the same line produce a convenient point of separation. If boards of varying lengths were used and consequently staggered, a failure at one point would be likely to pull down a large portion of the flashboard structure. As soon at the flood subsides, the water level is brought under control by the regulating gates and the spillway section that is free of flashboards is closed. Fig. 2 indicates the method of constructing the flashboards.

A complete set of "A" frames is kept on hand, ready to put in place. It is then a simple job to renew a set of flashboards.

In the summer, when the river flow is at a minimum, it is desirable to maintain as much water in storage as possible. To this end the height of the flashboards is increased to six feet. This extra board is tacked on, so to speak and with the first few feet rise in the pond level it is swept away and does not in any way endanger the dam.

This type of flashboard is more expensive than the original one, but the benefits derived through increased head, much greater pondage and ease of operation far outweigh the difference in cost.

Leakage Loss Reduced to Minimum

Furthermore, the crude method of fastening boards to steel pins made it impossible to prevent leakage through cracks, as the boards were rough and had to be overlapped at the ends. This was a serious loss during the dry season. On the other hand, with the new type it is possible to reduce leakage to a minimum through better facility for nailing to the upright posts and by squaring the edges of the boards and, where necessary, nailing strips over the seams.

The new boards are substantial and trim looking compared with the old style, and when first installed, the 900-ft. spillway afforded a beautiful sight when a smooth

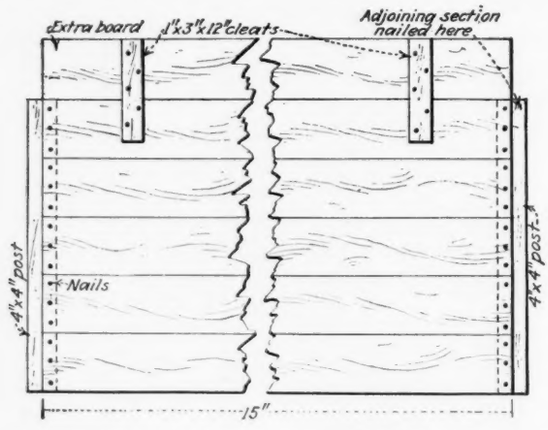


Fig. 2—The flashboards were built in sections to reduce the amount carried away in case of failure

solid sheet of water swept over it, but it was soon discovered that a vacuum existed back of the sheet of water. A vacuum behind a solid sheet of water sweeping over a dam is likely to set up vibration.

The method outlined in Fig. 3 was considered the simplest means of admitting air to destroy the vacuum. When water is flowing over the flashboards, the rush of air into the vacuum breakers is considerable, except when trash lodges on top of the flashboards. In the latter instance the trash serves to break the sheet of water and incidentally admits air, but it is not an effective means.

The original flashboards increased the station capacity about 8 per cent, but were not satisfactory for the reasons previously given. The present design increases the capacity of the plant about 15 per cent, or 7 per cent more than three-foot boards, and in addition the increased storage and other benefits previously enumerated are obtained. There is another item of importance—the increased volume of water impounded makes more kilo-

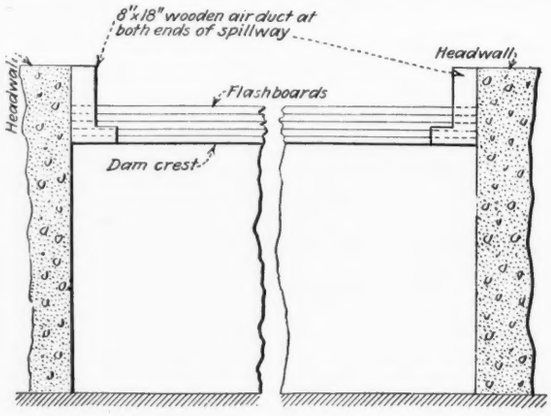


Fig. 3—Wooden air ducts were used at each end of the spillway to break the vacuum under the sheet of water flowing over the flashboards

watt-hours available not only at this plant, but also at plants downstream, through improved regulation of river flow.

Clinkering Tendency of Ashes Measured

FUSIBILITY is a measure of the operating troubles which can be directly attributed to the quality of the ash of coal burned on an underfeed stoker, the Bureau of Mines has announced.

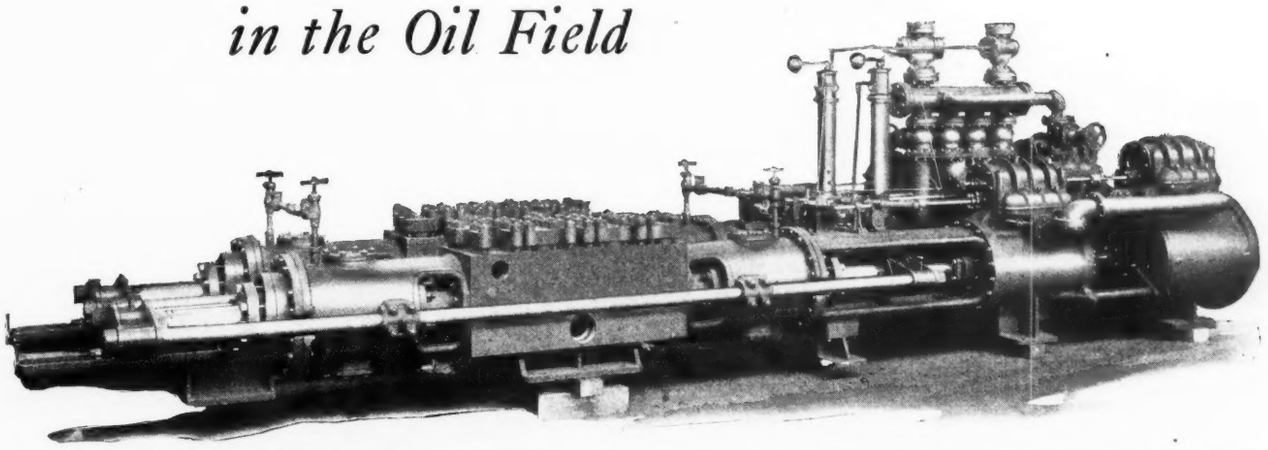
Engineers do not agree that relative operating troubles from clinkering when using different coals in the same furnace can be predicted from a knowledge of the fusibility of the average ash of the coals. It is difficult to allot the blame correctly and the difficulties may be due to differences in the burning characteristics or the combustibility of the coals, to the size of the coal pieces, or to the adjustment of the stoker or its operation.

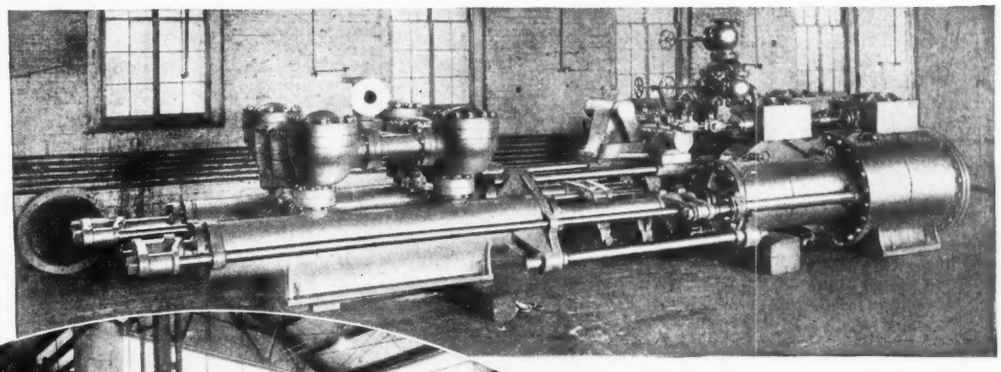
A series of tests has been made by the Pittsburgh Experiment Station of the Bureau of Mines at the boiler plant of an industrial firm in which five semi-bituminous coals having different softening temperatures of the ash but obtained from the same mining district, were burned on an underfeed stoker. Similar operating conditions were maintained throughout the investigation and similar tests were made with each coal.

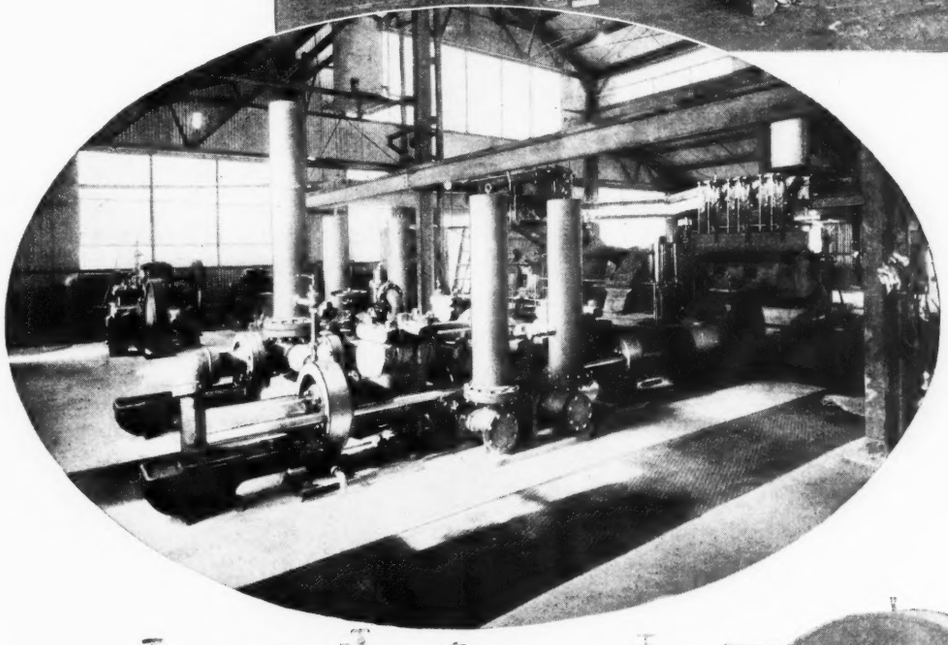
A summary of the results and observations shows that the quantity of clinker formed and the troubles attributable to clinker formation decreased as the softening temperature of the ash increased—that is to say, the coal having the ash of the highest fusibility gave the least trouble. It does not follow that given users would have found the same coals generally satisfactory in the same order, or that the conclusions reached would be the same with other methods of burning, but the investigation showed that the fusibility was a measure of such operating troubles as could be directly attributed to the quality of the ash in the coal.

High-Pressure Pumps

in the Oil Field

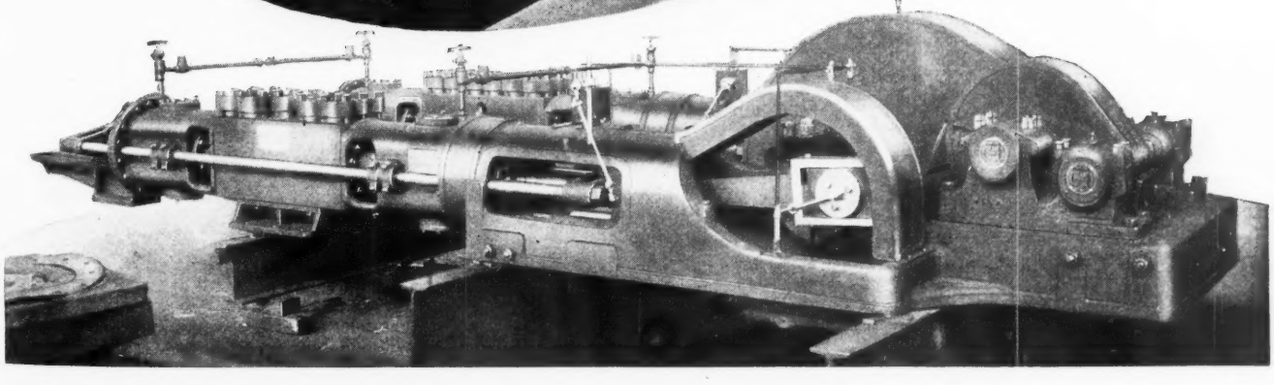






The needs of the oil industry have led to the design of high-pressure pumps, some steam driven, some geared to motors and others driven by oil engines.

Photos, courtesy Worthington Pump & Machinery Corp.



Refrigeration

Draws the Movie Fans

By C. T. Baker

Consulting Engineer,
Atlanta, Georgia

ON PEACHTREE Street in Atlanta, stands the Howard Theater, one of the South's finest and most popular playhouses. With a seating capacity of approximately 2,500 persons, the theater's aim has been to hold its patrons, and for this reason there has been installed a modern air-conditioning and ventilating system.

The public demand for comfort while viewing the movies has created a new field for the engineer. In the early days any old vacant building sufficed for the movie house, and the seats ranged from backless benches to rows of folding chairs. The discomforts of the hot, humid room were forgotten in the wonder of the celluloid strip of action. As the movie houses increased in number, the public became blasé and demanded a degree of comfort beyond that possible with natural ventilation and uncontrolled heating. The refrigeration engineer was called upon, and his success in air conditioning is attested by the millions who nightly attend these modern palaces of amusement.

There are in reality two distinct problems of air conditioning in the modern theater—that of heating, ventilating and humidifying in winter and that of cooling, dehumidifying and ventilating in summer. However, in all seasons the cleaning and purifying of the air is important as is also the preventing of drafts anywhere in the building such as would cause discomfort to patrons.

When first built, the heating and ventilating system of the Howard Theater consisted of the usual arrangement of steam radiators placed at points throughout the building calculated to maintain a fairly uniform temperature, while ventilation depended upon air circulation produced by fans. Neither the heating nor the ventilation met the exacting requirements of a modern theater, since fans could only partly relieve the foul and heated air within, while the supposedly fresh air brought from without was often hot and dirty. In addition to this, drafts could not be prevented, because of the inherent characteristics of the system employed for handling the air in and out of the house.

The method of heating in winter failed to produce uniform temperatures, since parts of the house would be too hot while other spots would be too cold. Then again, humidity control with the old system was out of the question.

To eliminate these shortcomings of heating and ventilation and at the same time provide humidity control, a modern air-conditioning plant was installed which entirely replaced the old order of things, providing fresh clean air at all seasons, properly washed and refrigerated in summer and properly washed and heated in winter.

The refrigerating machine consists of one 150-ton capacity centrifugal-type compressor furnished by the Carrier Engineering Corporation. This is directly con-

nected to a 200-hp. Crocker-Wheeler 220-volt three-phase 60-cycle motor, which drives the compressor at 3,550 r.p.m.

The motor windings are cooled and protected by means of an air duct through which cooling air is drawn from the outside of the building and circulated through the motor windings and out through a central duct, discharging the warm air at some distance from the entrance of the intake duct. During the hottest summer weather the air temperature leaving the motor windings does not exceed 110 deg. F.

The centrifugal compressor is mounted directly above the condenser, and the motor is carried on a separate cast-iron support. The compressor delivers the compressed refrigerating vapors into the condenser where liquefaction takes place. The cooling water is circulated through the tubes of the condenser in about the same manner as condensing water is circulated through the multi-pass surface-type steam condenser, and as the condenser is of the counterflow type, it gives a relatively high rate of heat transfer between the condensing water and the refrigerating vapors.

The refrigerant is condensed under a vacuum at a somewhat higher value than that existing in the compressor. The entire equipment, including compressor, condenser and evaporator, is at all times at a pressure less than atmospheric.

Condensing water is circulated by a Buffalo Steam Pump Company's centrifugal pump having a rated capacity of 550 g.p.m. when operating at 1,760 r.p.m. against a head of 90 ft. This pump is direct connected to a General Electric 25-hp. induction motor. The water supply for condensing purposes is furnished by an atmospheric cooling tower on the roof of the building. After being discharged through the condenser tubes the water is delivered to the top of the tower, where its load of heat is given up to the atmosphere in the usual manner. The evaporation and windage losses of the tower are made up by water taken from the city mains; the amount is automatically controlled by means of the usual float-operated control valve.

The passage of the liquid refrigerant from the condenser is automatically controlled by means of a liquid trap much on the order of the usual steam trap used for handling condensate from steam lines.

The liquid flows by gravity from the bottom of the condenser, through the trap and to a point some distance above the bottom of the evaporator.

Generally, the water supply to the condenser is controlled by hand operation of the stop valve on the discharge line to allow approximately only enough water to pass through the condenser to carry away the heat dumped into it by the compressor. However, in addition to hand regulation, there is provided an automatic regulator known as a single-duty regulator, the function of which is to throttle automatically the water supply to the condenser as the load drops off. This regulator is automatically opened or closed as the requirements de-

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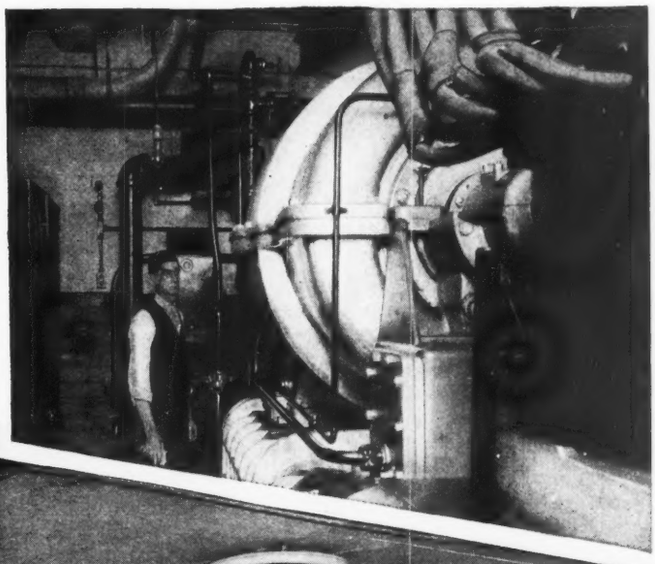
Fig. 1 (Right)—The refrigerating machinery occupies but a small space

Fig. 2 (Below)—The theater interior, with the air inlets shown in the ceiling



mand, by a change in temperature of the liquid in the evaporator in which the water used for air cooling is being refrigerated. As the liquid temperature in the evaporator rises above normal, the automatic control admits more water to the condenser, and when the temperature falls below normal the amount of water admitted to the condenser is reduced.

The single-duty regulator was supplied by the Taylor Instrument Company, and air for actuating it is supplied by a small air compressor mounted on one end of the evaporator.

The water cooler used in this system is a multi-pass unit, having a heavy ribbed cast-iron shell with $\frac{5}{8}$-in. admiralty-bronze tubes expanded into admiralty-bronze tube sheets. All tubes are annealed at the ends before expanding into the tube sheets and proper provision is made to care for the tube expansion and contraction.

A small centrifugal pump driven by a two-horsepower motor removes the liquid refrigerant from the bottom of the cooler and discharges it into a liquid distributing system at the top, so arranged as to flood the entire tube surface as it showers over the tubes in passing downward. This insures rapid evaporation and rapid cooling of the water passing through the tubes.

Should the water supply to the tubes fail for any reason, the pump circulating the liquid refrigerant is automatically stopped. This also occurs when the water temperature falls below the predetermined value. Thus complete protection is given against freezing, for the stopping of the liquid pump also stops the refrigerating action within the cooler.

Automatic Safety Controls Prevent Water from Freezing

Since water and not brine is passed through the tubes of the cooler in this installation, the manufacturers have developed three practical automatic safety controls to prevent the water from freezing. Two of these controls are arranged to stop the liquid pump, while the third shuts off the water supply to the condenser.

One of these is a Tycos regulator, provided with a long bulb and located in the path of the water leaving the cooler. When the water is cooled below some predetermined point; the regulator energizes an electric relay, which in turn opens a magnetic switch on the motor driving the liquid pump and immediately causes the pump to stop. After the water has warmed up to the desired temperature, the same regulator automatically starts the liquid pump again, establishing refrigeration in the system.

Ordinarily, the temperature for which this regulator is adjusted and made to operate is about five degrees below the lowest desired temperature of the water leaving the cooler, but never below 34 deg. F. in coolers used for the cooling of water.

A second method of automatically controlling the starting and stopping of the liquid pump is by means of a pressure-differential control, which is operated by a pressure differential produced by an orifice plate in the flow of water through the cooler. The protective device functions when the amount of water flowing through the orifice is reduced to approximately one-half of the normal quantities. Such a reduction causes the differential control to operate a pilot and relay, which at once stops the pump circulating the liquid refrigerant in the cooler.

Water to be cooled is delivered to the evaporator by means of a 500-g.p.m. Buffalo centrifugal pump designed to operate at 1,735 r.p.m. when under a 140-ft. head and directly connected to a 30-hp. motor. After leaving the cooler, the refrigerated water is delivered to a large air conditioner located in a large penthouse on the roof. The air conditioner is provided with a series of small spray nozzles through which the refrigerated water is discharged in the form of a very fine mist or spray, while the air to be conditioned passes through this mist, by means of a large fan belt driven from a 685-r.p.m., 40-hp. motor.

On an average the water temperature is cooled through a range of seven degrees in pasing through the tubes of the evaporator, and under normal conditions the water will enter the cooler at about 52 deg. F., leaving at 45 degrees.

After passing through the sprays and descending to the bottom of the air conditioner, the water is returned through an insulated line to the water-circulating pump

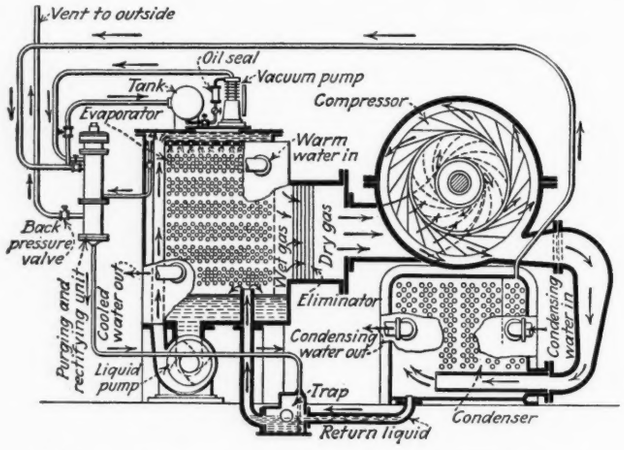


Fig. 3—Diagram of the refrigerating machinery

to be passed through the cooler again. The air being conditioned for the theater enters at one end of the conditioner, or dehumidifier, and leaves at the opposite end. It is then carried through an insulated duct to the various points of distribution in the theater proper and finally recovered at the floor line and returned through a second insulated duct to the conditioner.

A damper in this return duct at the dehumidifier is automatically controlled simultaneously with the damper in a duct bringing in air from the outside. When the damper is being opened to the outside to admit outside air, there is at the same time a partial closing of the damper on the main return duct.

The galvanized iron duct which distributes the conditioned air to the various points in the theater, is carried direct from the fan outlet at the conditioner, across the roof of the main building and is supported on concrete sills.

From this main duct the necessary distribution laterals are taken off to the ceiling outlets. The air, which has been washed, cooled, humidified or dehumidified in passing through the refrigerated water spray of the air conditioner, enters the theater through openings in points well above the balcony. It slowly descends to the floors, to be removed through suitable floor outlets connected to return laterals, which in turn are connected to the main return duct.

A section of the main balcony ceiling with the air-diffusing outlets in place, appears in Fig. 2. By this

arrangement air distribution throughout the entire theater is such that there are no drafts, while the proper conditions are maintained at all times.

As the cooled incoming air is diffused and made to spread evenly over the entire upper area high above the seats, it mixes with the air already present, causing a slow but positive downward movement, absorbing the heat and moisture given off by the occupants of the seats along with the carbon dioxide exhaled in breathing. Before the air actually reaches the occupants of the seats, its temperature and humidity have reached the desired values. As this air continues to take up heat and moisture, and is warmed and moistened above these ideal values, it is removed through the air outlets at the floor line.

For heating and otherwise conditioning the air in winter, much of the same equipment is employed as used in summer; however, the centrifugal compressor and other parts of the plant proper are not used in winter.

The air is passed through the air conditioner, where it is washed by contact with the spray water. In addition to this, the air is humidified by the relatively warm spray and thus takes up sufficient moisture to produce the required humidity. Leaving the spray, the air passes over and through sections of steam radiators in which steam at approximately five pounds pressure is carried.

Water stands in the tank section of the air conditioner from twelve to fourteen inches above the bottom, so that dirt and other foreign matter washed out of the air collects below the suction outlet to the circulating pump, whence it is drawn off and the tank washed out with a hose at intervals. An overflow is provided at one end of this basin for taking care of the increase in the amount of water caused by moisture precipitation from the air while it is being conditioned in summer. For makeup water in winter an automatic float admits water from the city mains as needed.

During the winter months it is sometimes necessary to heat the spray water slightly to prevent freezing and to temper it to assist the air in taking up the required moisture. Outdoor winter air contains little, if any, moisture, and to heat such air to 70 deg. F. without adding moisture would result in a very dry indoor atmosphere, such as causes headaches, colds and other winter ailments. Air circulation throughout the theater in winter is identical with that of summer, since it passes through the same system of inlet and outlet ducts.

A diagrammatic outline of the essential units of the Howard refrigerating machine, including compressor, condenser, evaporator and purging outfit, is shown in Fig. 3 and serves to illustrate quite clearly the events in the complete cycle of the refrigerant in passing from the compressor through the various apparatus and returning to the compressor intake.

Part of these data were obtained through the courtesy of R. E. Hicks, manager of the Howard Theater and of J. J. Rebeske, chief engineer, who is responsible for the highly successful operating results of the air-conditioning plant.

The Human Side of Waste

By L. Hansen
Chief Engineer,
Southwestern Light & Power Company

Waste is caused by—

1. **Jealousy, distrust and resentment among foremen and workmen.** Disputes and hard feelings are more costly than mechanical breakdowns, because they spread from one department to another. If not stopped, they may break up an entire organization.

2. **Fake promises and false hopes built up in the minds of workmen by making promises that have no foundation.** Few promises can safely be made outright. If a department head makes false promises to the men under him, he is unfair to the company and taking undue advantage of the workman he makes the promise to.

3. **The wrong view a workman has of his job.** A foreman's lack of ability to correct discontentment among workmen before it grows to such an extent that a dismissal will be necessary.

4. **Buried treasures.** A department head's ability to teach a workman to think along right lines will help the department as well as the workman. Treasure his brilliant ideas and point out the errors in ideas that are not correct.

5. **A foreman's lack of ability to explain to a workman the significance of his job.** The value of the job to the workman and his family, the care of his person to keep down accidents.

6. **The department head's lack of ability to handle a "grouch."** Failure to allow a workman to get things "off of his chest."

7. **The foreman's lack of ability to keep from being "fog bound."** Explain in detail and in simple language, the most efficient way of doing the work.

8. **Foremen's lack of ability to increase efficiency by increasing teamwork.** Only the foreman that is short in ability need worry about authority over men. Never ask a workman to do what you can't do yourself.

9. **Head of a department's lack of ability to eliminate excuses, alibis and "buck-passing."** The same brain power, imagination and ability that are needed to fix up an airtight alibi will accomplish wonders when put to work at useful production.

10. **The foreman who loses his temper.** Remember that anger is a universal destroyer, and any man must pay a long price for a short temper.

11. **A department head's failure to salvage.** In thousands of departments in all lines of business some workers are considered "incompetent" when, as a matter of fact, they are merely "misplaced," trying to do work for which they are not fitted. These workmen are often discharged when they should be transferred or shifted to some other class of work.

12. **Failure in courtesy.** Win the confidence of the workmen by remembering that all men are human. Learn to teach and not drive. By the proper use of courtesy you acquire the respect of each member of your department. This respect in turn builds up the efficiency to such extent that the troublesome small leaks that go to make big ones are stopped.

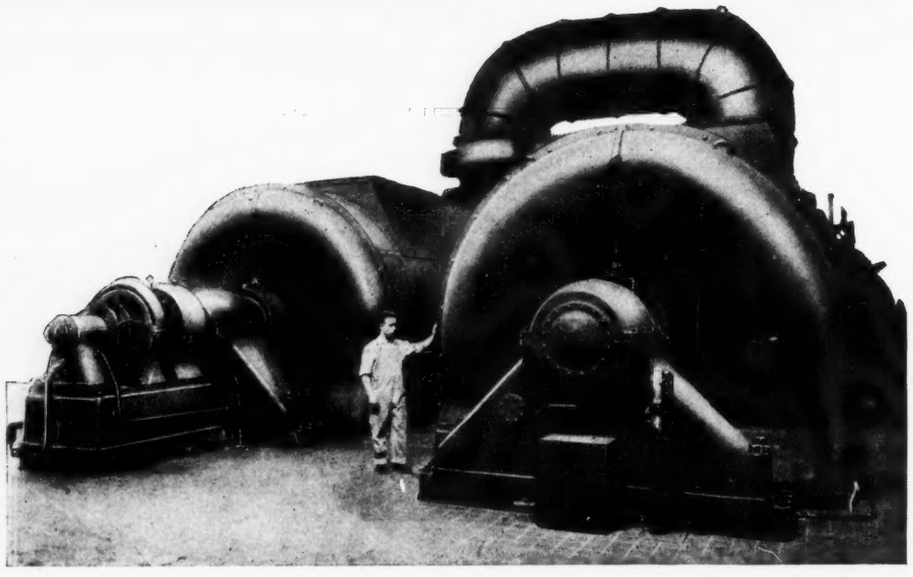


Fig. 1—Generator end of the 110,000-kw. unit at Hudson Avenue

Features of
110,000 Kw. Unit
at Hudson Avenue

By J. N. Landis

Plant Equipment Engineer, Brooklyn Edison Company, Inc.

THE Brooklyn Edison Company, in its Hudson Avenue generating station, has recently started operation of a 110,000-kw. turbine-generator set with its attendant equipment. This machine and the 85,000-sq.ft. single-pass condenser serving it again establish the record for the largest operating equipment of the type.

The turbine is a Westinghouse cross-compound machine, designed for 400 lb. pressure, 700 deg. total temperature and two stages of feed heating. It is served by four Westinghouse underfeed-stoker-fired Babcock & Wilcox boilers of 23,830 sq.ft. heating surface, equipped with 14,960-sq.ft. return-bend type economizers. The stoker is distinctly novel in that a 33-tuyere conventional underfeed area feeds onto a short length of essentially chain-grate area arranged to reciprocate up and down in sections to produce a wave-like motion moving the coal to the clinker grinder pit; also in that in the front wall of the clinker grinder pit all cast iron has been eliminated by building the front pit wall of hard-burned paving brick with a cooling-water spray over it. The furnaces are surrounded by Bailey water walls on three sides and a carborundum front wall. The forced-draft and induced-draft fans will control air or gas pressure and volume through the use of movable guide vanes in the fan inlets. These novel features, together with other unique practices used in the engineering specifications and equipment purchasing, make the Hudson Avenue No. 5 unit different from the majority of present-day station layouts.

The record of what has been done in this station is interesting because, although the station was started originally with the conception of installing 50,000-kw. units, now a 110,000-kw. size has been installed. This decided increase in capacity has entailed an unusual amount of engineering.

When starting the engineering of the No. 5 installation, the outstanding desire was to decrease station investment costs per unit of capacity, and it was recognized this could be done by the installation of large units. Operation of the 80,000-kw. unit had shown the possibility of carrying that load on three boilers for peak conditions. Four new boilers were to be added with the new installation, and it was felt that at times of peak load seven of the eight boilers for units Nos. 4 and 5 could reasonably be expected to be available. It was reasoned that three of these would carry the 80,000-kw. machine and the remaining four could supply steam to an approximate 100,000-kw. machine. It was decided to specify a machine of this capacity with a limiting allowable heat rate at maximum load of 12,000 B.t.u., to correspond with extremely adverse summer conditions of 27.5 in. vacuum. One of the turbine manufacturers requested the privilege of bidding on a machine with a capacity in excess of 100,000 kw., but which would not consume more heat than that specified as maximum allowable for the 100,000-kw. machine. Accordingly, a premium was offered for capacity obtainable above 100,000 kw. at the named heat consumption due to machine efficiency, with

the final result that a Westinghouse cross-compound turbine was purchased capable of carrying 108,600 kw. when consuming 1,200,000,000 B.t.u. with 27.5 in. vacuum. The manufacturer decided to build and rate this machine for 110,000 kw. at 27.5 in. vacuum.

The turbine, with few exceptions, is of the same general design and construction as the No. 4 turbine which was described in the Nov. 30, 1926, and Jan. 11, 1927, issues of the shafts, instead of being driven by gears from the shafts as on No. 4.

This is the first unit on the Brooklyn Edison system to be furnished with a turning gear for rotating the spindle at low speed when the turbine is shut down in order to prevent kinking of the spindle. This device is thrown in gear when the spindle is slowing down, continues to rotate the spindle during the entire period of shutdown

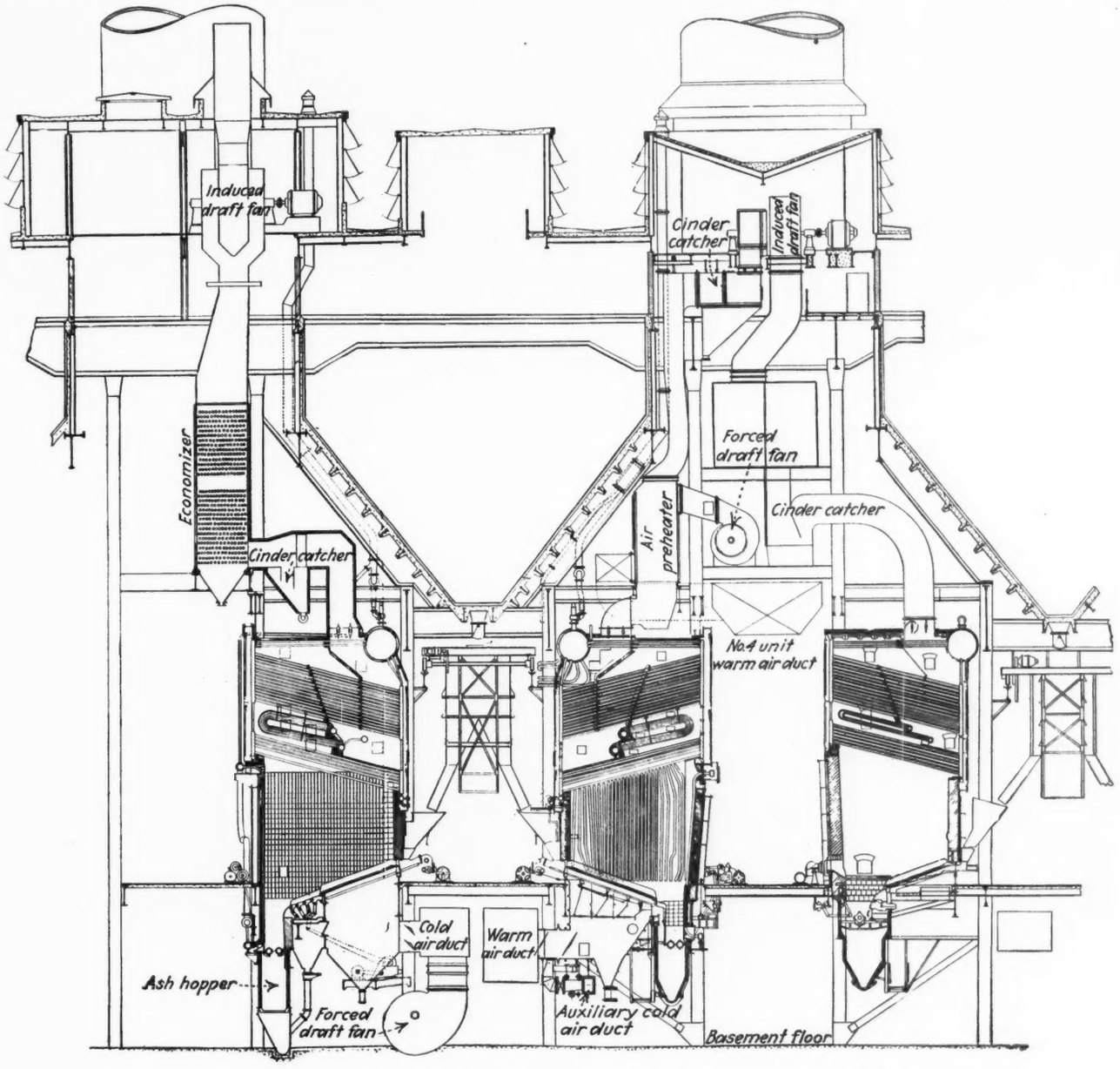


Fig. 2—Section showing No. 5 boilers and the two previous installations

of Power. The No. 5 unit is provided with five steam admission valves in contrast to the No. 4 unit, which has but three. This is due to the great stress the Brooklyn Edison Company put on the value of a machine with a flat water-rate curve. Stainless steel is used throughout the turbine for the rotating blades. The use of this material permitted the design of the blades for greater stress than would ordinarily be allowable, thus making possible the use of longer blades and higher tip speeds than used heretofore. On this unit the oil pumps are single-stage centrifugal oil pumps mounted on the ends and is thrown out of gear when the machine is started up.

A novel method was used in the purchase of the condenser. The specification made no mention of the number of water passes, tube size, water quantity, or tube surface desired. Instead of defining these elements, the specification was devoted to a complete description to the manufacturers of the operating conditions and of the exact process to which their proposals would be subjected in making the purchase selection. This method of handling the business enabled the condenser manufacturers to select the best offering to make by going through the

identical process later to be applied by the purchaser. The condenser negotiation ended with the purchase of an 85,000-sq.ft. single-pass condenser, the largest of this type in operation. This constituted a change in company practice with reference to condenser engineering, two-pass designs previously having been specified. The conclusion should not be drawn that only single-pass condensers will be installed in the future. A limitation exists in the amount of water that can be handled through the circulating water tunnels, due to the original station layout having contemplated an ultimate capacity of but 400,000 kw. For this reason a maximum water use of 135,000 g.p.m. was allotted to this installation. As something approaching this same water quantity limitation will be specified for future Hudson Avenue condensers, it is possible that if turbines even larger than the No. 5 are installed there will be a reversion to the use of two-pass condensers. The condenser is of the Westinghouse radial-flow type, and the condensing surface consists of 14,400 tubes 26 ft. long, $\frac{7}{8}$ in. in diameter. The steam-jet air-removal equipment consists of three three-stage air-removal jets with the air-removal piping so arranged that one of the banks of jets normally will be connected individually to each of three longitudinal steam space compartments formed by two tube-support sheets. In this manner each jet will produce the air-removal suction required by its particular compartment as determined by the pressure drop through it. Circulating water is supplied by two 67,500-g.p.m. pumps, each driven by a two-speed squirrel-cage motor with switching provisions at the motors.

Feed heating is accomplished by means of two stages of extraction from the turbine. The path of condensate flow is shown in the diagram, Fig. 4. Two stages of feed heating were selected because of the use of economizers in the boiler house; also to simplify the turbine-room basement layout.

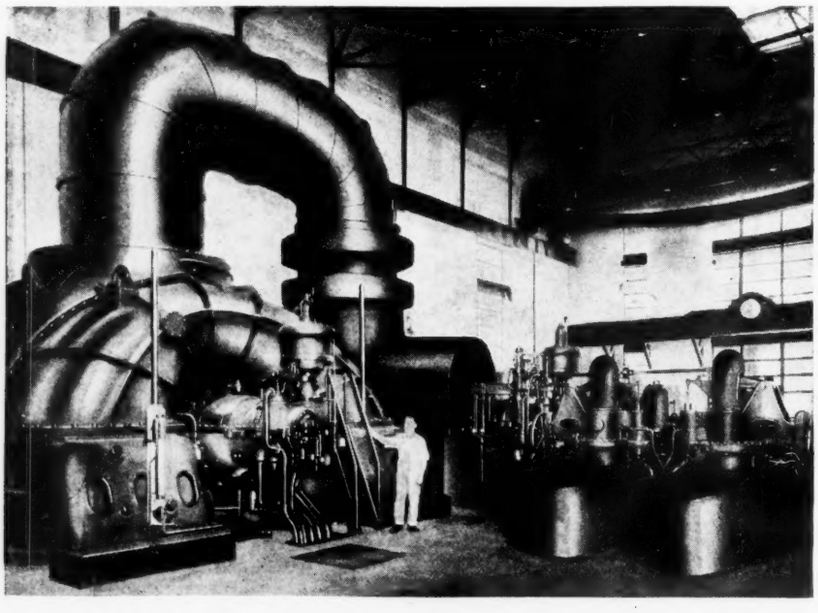


Fig. 3—The steam end of No. 5 turbine generator

In consideration of the boiler-house and turbine-room basement layout, a careful comparison was made of economizers and two-stage feed heating versus air preheaters and four-stage feed heating. Experience with preheated air had been gained from No. 4 unit, and while no handicaps faced the repetition of the use of preheated air from the viewpoint of using preheated air in conjunction with stokers, there were definite objections to its use because of layout difficulties. The original building design of Hudson Avenue station did not contemplate installation of air preheaters, therefore adequate space is not available around the boilers to bring down individual preheated-air ducts. The carefully prepared investment and operating cost analysis showed a slight capitalized saving in favor of installing air preheaters, but it was judged that the handicaps against the necessary air preheater layout were sufficient to overbalance the preference for preheated air shown in the comparison of tangible items. As the design with economizers actually materialized, it resulted that somewhat greater boilerhouse capacity was secured than in the case of the preceding air installation, and this with a simplified layout.

In the handling of the boiler, economizer, water wall and stoker business, effort was made to allow each bidder as much latitude as possible in making the most advantageous proposal. To this end the specification, rather than containing a specific extent of boiler and economizer surface desired, instead consisted of a complete set of layout drawings showing the space in which the apparatus would be installed, together with a binding definition of the quality required and of the conditions under which the equipment would be expected to operate. The specification was otherwise largely concerned with a description to the manufacturers of how the proposals would be judged comparatively.

It was believed that considerable advantage would result from placing with one manufacturer the contract for the boiler, economizer, water wall and all steelwork involved in conjunction with these. Bids were secured in such a way as to permit placing component parts of the equipment with different manufacturers if it should appear desirable, but finally the four major elements named, together with the cinder eliminators, soot blowers, feed-regulator valves, boiler casing, flue work between boiler and economizer, and boiler drain and soot-blower piping, were all placed with the Babcock & Wilcox Company, with the further understanding that they care for all the detail work of preparing construction drawings to co-ordinate the several parts of their own contract and in addition the separately purchased stoker.

The boiler-room layout is shown in general in the section drawing, Fig. 2, which has been prepared to show one of the No. 3 unit boilers, typical of the first three rows of boilers, one of the No. 4 unit, and one of the No. 5 unit. These layouts show progressively the stages of the boiler-house design.

The stokers for the No. 5 unit are a distinctly new design in that they embody a conventional type of underfeed section 33 tuyeres long discharging across an approximate six-feet width of rocking link grate just ahead of the ashpit. The link-grate section is made up of frame castings into which are inserted links quite similar to those used in chain-grate stokers. By a system of supporting arms carried on fixed pivots, together with others

carried on rocker arms, this link-grate section is caused to reciprocate up and down with a wave-like motion, breaking the coke and feeding it down to the ashpit. The entire projected stoker area, including the pit, is 524 sq.ft.

The stoker is provided with one driving motor for the underfeed section proper, two driving motors for the clinker grinder, and a fourth motor for the rocking-grate section. The rocking-grate section was arranged to be driven independently in the interest of segregating the drive from the stoker proper, because of uncertainty as to the exact requirements of motion in relation to the rest of the stoker. In addition to speed control of the rocking-grate drive motor, further control is possible through a two-speed gear box. A stroke adjustment is provided for amplitude or lift control.

Future designs conceivably may be simplified in respect to drive as experience is gained in operation. The stoker installation is also novel in that the front wall of the clinker grinder pit is constructed of hard-burned paving brick over which a small supply of water drains continuously to keep the brick cool, thus eliminating a section of stoker which previously caused considerable maintenance expense.

of Babcock & Wilcox Company "No. 80" brick, for trial. Exceptional effort was made to secure a tight furnace and boiler setting. Johns-Manville type water wall casing is used.

The boiler contains 23,830 sq.ft. of heating surface in conjunction with a three-pass superheater. A space equivalent to that of one tube is omitted between the bottom first and second rows of tubes, and to provide access

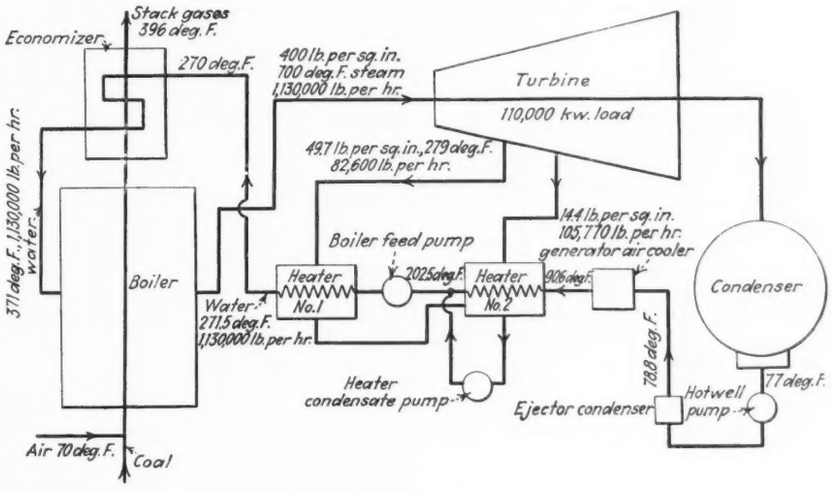


Fig. 4—Heat-balance diagram for No. 5 unit

The sectional drawing of the boiler house shows a departure from the system of continuous hydraulic sluicing used on the first four rows of boilers, the intermittent type being installed instead. The No. 5 unit utilizes for its ash handling the Allen-Sherman-Hoff "Hydrojet" system. In the Nos. 1, 2, 3 and 4 designs the ash sluice was open between boilers, and it was found that when operating with the high fuel-burning rates of the No. 4 row boilers, air admitted to the clinker grinder pit to burn out the combustible in refuse would short-circuit through the rolls instead of passing to the furnace. At high ratings, thus, the rolls were in danger of burning and extreme care had to be exercised in their operation. The condition was aggravated by the fact that the "popcorn" blown over into the ashpit from the fuel bed tended further to seal the air away from the furnace. With no air passing through it, this blown coke failed to burn and accumulated to depths sufficient to impede the flow of fuel on the stoker. These conditions have now been eliminated by sectionalizing the sluiceway between boilers and sealing it to such an extent that full windbox pressure can be carried under the clinker grinder rolls. However, at the time of purchasing the stokers this solution had not yet been effected. Because the stoker manufacturer made an appreciably better guarantee of maximum fuel-burning rate and combustion efficiency on the condition of the ash-handling system being capable of carrying a positive pressure, it was decided to install the Allen-Sherman-Hoff system, which embodies sealed ash storage except when sluicing and permits carrying a pressure under the rolls. In order definitely to centralize the responsibility for the two elements working together, the contract for the ash-handling equipment was made a part of the stoker contract.

The furnace is of the Bailey water-wall type on the two side walls and bridge wall. The front wall for three boilers is built of carborundum brick which has been found to give good service, and for one boiler it consists

to this space for lancing slag, small access doors are provided in the front and rear boiler headers.

A Green "cinder trap" is installed between the boiler and economizer. Cinder removal from the cinder trap hoppers is by means of a suction system discharging by means of a steam-jet evactor.

The economizer is of the Babcock & Wilcox return-bend type consisting of 14,960 sq.ft. of heating surface arranged 50 rows high, 26 tubes wide, of 2-in. tubes, 22 ft. long. The upper half of the economizer, as shown in the boiler-house cross-section, is arranged for counterflow of gas and water, and the bottom half is arranged for parallel flow. The discharge water from the upper half is brought into the bottom of the lower half and flows upward. This arrangement was selected by the maker to minimize the likelihood at low rating of steam forming in the economizer and working its way to the top, causing water hammer. A careful check of the sacrifice in efficiency due to half of the surface being parallel flow instead of counterflow, showed a decrease of one-twentieth of one per cent—entirely negligible.

The forced- and induced-draft fans used constitute a departure from conventional design. Both are of the B. F. Sturtevant Company "vane-controlled" type. Control of air pressure and volume is secured by movable guide vanes or shutters in the inlets to the fans. By placing these vanes at different angles, various degrees of "spin" are given to the air or gas entering the fan, with the result that with the fan wheel traveling at constant speed, the wheel velocity relative to the air is decreased the greater the "spin" of the air admitted to the wheel. In this manner the air volume and pressure are controlled gradually in contrast to the discontinuous variation secured with resistor control in steps. A decided virtue of the method of control in contrast to dampering on the outlet is a less consumption of power.

In other details the design has followed closely along the lines established in earlier installations in the station.

Adapting Engines to the Cheapest Fuel

By G. Grow

THERE is a tendency in engineering to specialize. As a result a plant built to burn Illinois coal cannot use Eastern coals economically; in other words, to obtain efficiency the choice of fuel has been restricted. The same situation exists in the internal-combustion engine field. Engines must burn the fuel for which they are designed. But in a number of instances manufacturers have built engines that could, with minor alterations, be run on different fuels.

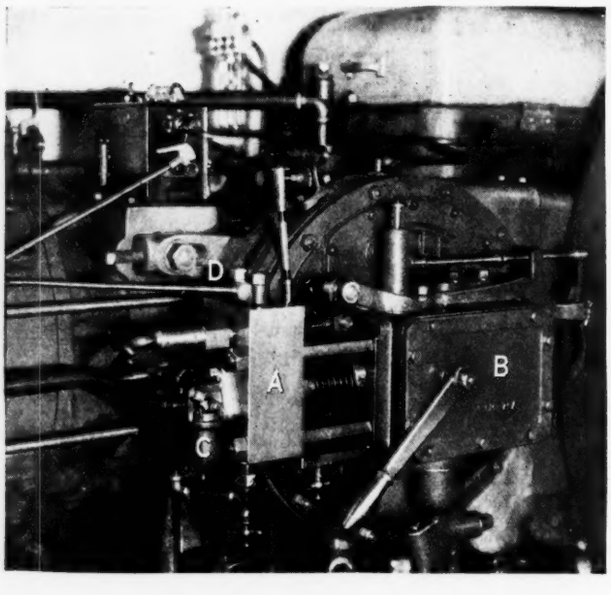
Years ago builders of gasoline engines, even of small capacity, supplied a second fuel-feed valve and a water-drip cock, to permit the engine to run on kerosene after an initial warming period on gasoline. This was not universally successful as it introduced lubricating difficulties, and on small engines the saving in fuel cost was not enough to justify the bother.

Similarly, such engines even, at times, were provided with a gas-mixing valve and were run on either gasoline or natural gas.

On large engines using natural gas such shifting devices have never been practical. The different compression pressures needed for efficient operation on fuels of different characteristics, precluded any method of instantaneous switching to another fuel. In fact, many gas engines have been abandoned when the gas supply disappeared, and oil engines installed.

Economy dictates a new order of engineering, and at present a number of gas-engine builders are marketing a combination engine to operate on either natural gas or fuel oil. Various conditions brought about these designs, such as the situation in Michigan, where a gas field has been brought in, but its dubious life makes the purchase of a straight gas engine for power purposes inadvisable. Likewise, in the Oklahoma and Texas oil fields there is usually enough gas coming from the oil wells being pumped to supply fuel to the pumping engine. But gradually the gas pressure drops until another fuel must be used. Where it is necessary to pump air into wells to induce the oil flow, the same conditions exist. The economy of having a double-fuel engine is evident.

Fig. 1—Fuel pump of Cooper engine



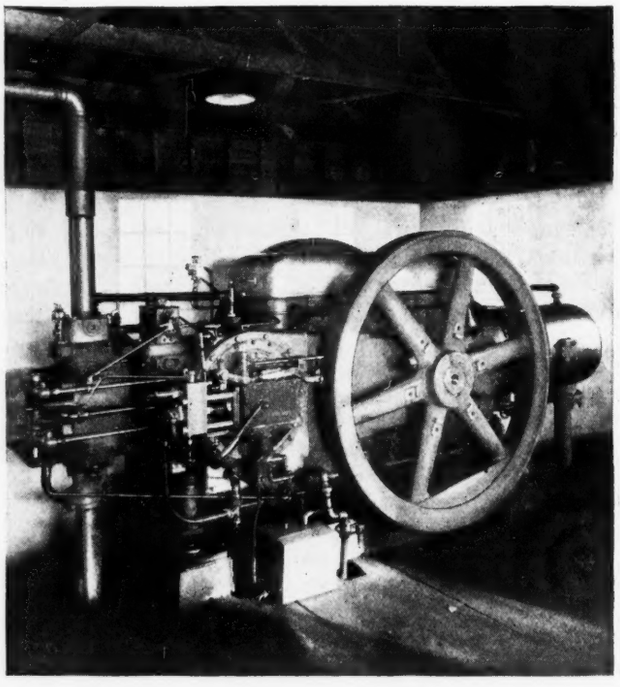


Fig. 2—Cooper convertible Diesel engine

A double-fuel engine must be built to withstand the pressures occasioned by the use of the fuel oil. Consequently, an engine built for gas may not be strong enough to operate under the 400 to 500 lb. compression of the Diesel cycle.

The double-fuel engine, then, must be designed for the service, and it may be unsafe to alter an engine now in the field from gas to oil burning.

An interesting unit of the convertible type is shown in Fig. 2. This, as illustrated, is arranged for oil fuel and is direct-connected to the compressor which it drives. The camshaft, which has Timken roller bearings, is mounted alongside the cylinder and is driven from the crankshaft by a silent chain. The fuel pump *A* is bolted to the camshaft housing *B* as shown in Fig. 1. The

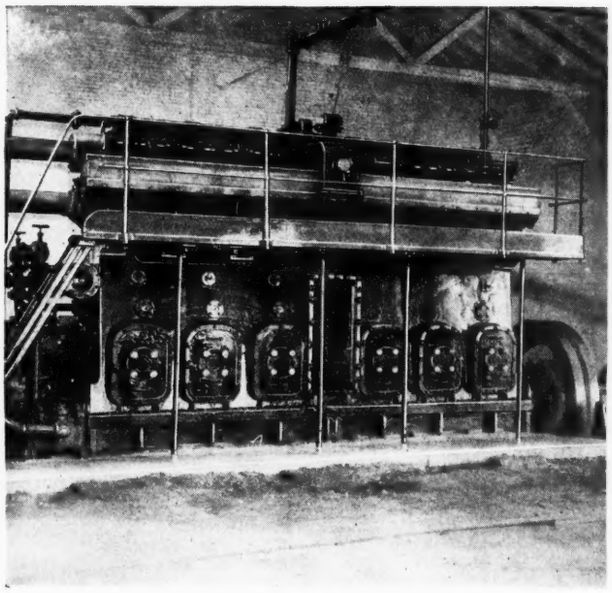


Fig. 3

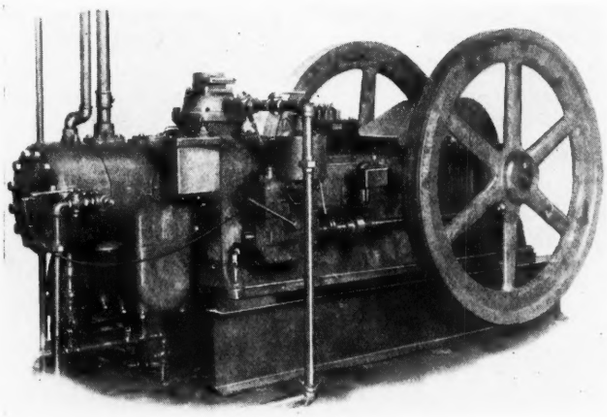


Fig. 4

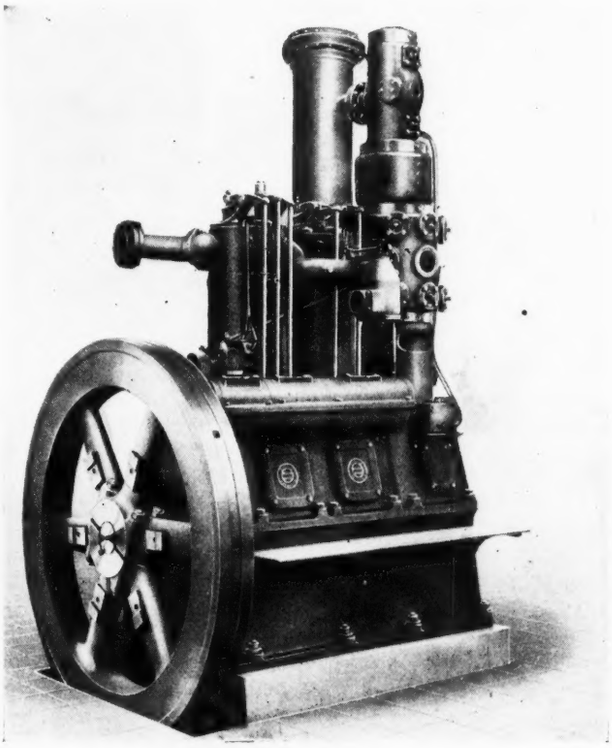


Fig. 5

oil-pump suction line is supplied with two filters *C* and the oil to the nozzle leaves the pump through the pipe *D;* the governor-controlled bypass valve connection is at *E,* with the governor inclosed in the camshaft housing. But one fuel nozzle is used; this is placed in the center of the head, and is provided with a check valve. A check valve at the nozzle is necessary, since the pump has no discharge checks. The removable cylinder liner is 12-in. in diameter and the piston has a 16-in. stroke; at 300 r.p.m. it is rated at 50 horsepower.

Another outstanding example of the convertible engine is the 410-hp. Bessemer unit installed at the plant of the Excelsior Buck Company, Fredonia, Kan. This unit, Fig. 3, is, in fact, a six-cylinder Diesel with the fuel pumps and spray valves removed and a gas mixing and magnite valve added. This arrangement protects the owner against any failure of the Kansas gas supply.

Still another notable example is the unit shown in Fig. 5. This embodies the frame cylinder and valve gear of the Benz solid-injection Diesel. The builders, the Chicago Pneumatic Tool Company, replaced the oil pump by a magneto, and inserted a spark plug in the spray valve opening in the cylinder head. The substitution of another piston to give lower compression pressure permitted the engine to operate on natural gas. Some 75 of these 45-hp. engines with the compound air cylinders were installed in the Oklahoma oil fields for well-blowing purposes.

The high-compression oil engine is not the only engine that has been altered to use natural gas. In Fig. 4 is a view of a 65-hp. Superior semi-Diesel arranged for natural gas. This engine is of the two-stroke-cycle type, employing the front end of the cylinder for the scavenging air compressor. As with all such engines a crosshead is incorporated in the design. To change the engine to gas, the gas line is led to the scavenging-air intake valve at the top of the cylinder. The gas is drawn into the compressor along with the air, and when the piston uncovers the exhaust ports, the scavenging is performed by the mixture of gas and air. The fuel pump is displaced by a magneto, and a spark plug is inserted in the cylinder head where normally the fuel spray nozzle rests. The difference in compression is obtained by changing the piston.

Fig. 3—A Bessemer Diesel using natural gas

Fig. 4—Natural gas attachments of the Superior semi-Diesel engine

Fig. 5—A solid-injection Diesel arranged to run as a gas engine

Byproduct Heat and Power

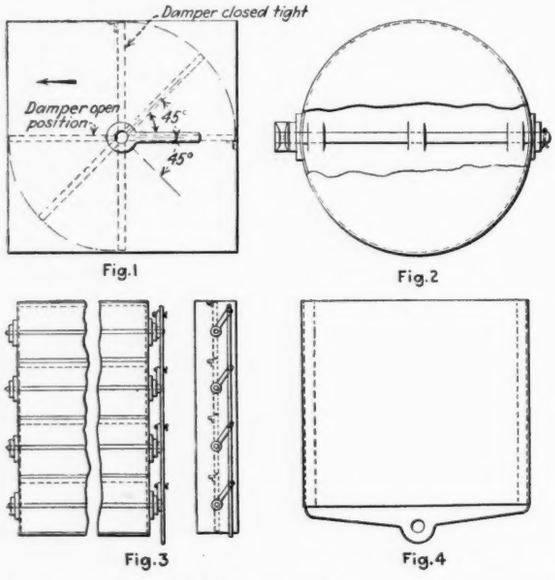
Better use of byproduct heat and power will save millions for American industry. Each plant must arrive at an individual solution of this problem, but each can learn by studying other plants and other industries. An article in an early issue will show the close tie in of power and process heat in a typical paper mill.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

Pointers on the Selection and Use of Boiler Dampers

WHEN one stops to consider the amount of attention that is given to the design of a boiler, a stoker, a fan or other auxiliary, then to the operation of them after they are installed, it is discouraging to see the lack of attention that is given to the design and to



Figs. 1 to 4—Standard types of dampers in general use

the operation of a damper or dampers used to govern the combustion of the fuel in the furnace.

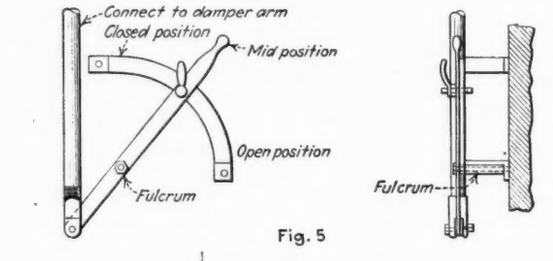
In a natural draft, induced or forced-draft stoker installation or practically any type of boiler installation, including pulverized-coal and waste-heat boilers, the air for combustion and the velocity of the gases through the boiler are controlled by a damper or a number of dampers. With the installation of preheaters in the larger installations, also air-cooled walls, air-cooled arches, etc., several dampers are used on a single boiler unit.

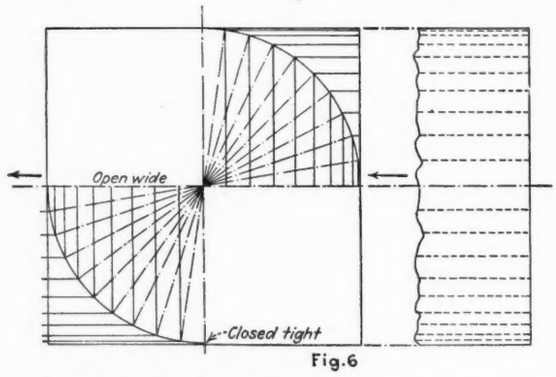
The types of dampers in common use include the square-plate-type damper, which is swung from the middle, as shown in Fig. 1; the butterfly damper, Fig. 2; the louver or shutter damper, Fig. 3; and the sliding damper, Fig. 4. Then we also have the full-swing hinged damper.

The two important points to be considered when designing a damper are the size and the type. For an example, let us take a typical boiler-house installation. The boilers, stokers and their auxiliaries being standard for the ratings desired, the other necessary parts to be figured are the steam headers, the stack, the fan for the forced draft and the dampers. The steam-line header is figured large, the fan large, the stack large, this being good engineering practice. The size of a damper (the uptake and ducts considered with dampers, but not the breechings or main air ducts from the fan) should be figured out so that it will be large enough to take care of the gases from the boiler when the boiler is steaming at its maximum rating and not figured on the basis of future development, which seems to be the general practice.

The other extreme, the damper being too small, is generally the result of replacing a small boiler with a larger unit and owing to time limits and other reasons, the other auxiliaries, which include the dampers, are all left as is, consequently they are all too small for the new boilers and stokers.

There are a number of factors governing the type of damper to be used on a job. There is the cost, amount of space available, the practicability of certain types of dampers, taking general conditions into account, such as class of help, boiler load, etc. Fig. 5 shows a common method of manually operating the uptake damper from the floor level. The stiff-arm principle of interconnecting is shown, eliminating the necessity of using weights.





Figs. 5 and 6—Method of connecting damper arm and diagram of openings when change is made in equal steps

The proper way to control the damper would be, instead of having the damper position change in equal measured steps (see Fig. 6), to change so as to give equal pressure changes. The only trouble with this idea is trying to make it practical by the hand method of control. It can be done much better by the automatic system.

While out on a job not so long ago, I was asked by an engineer of a neighboring plant, to call and give him a figure on the cost of installing a combustion-control system. The next day, having a little spare time, I went

over to his plant. After asking the usual questions, such as number of boilers, types of boilers, steam pressure, etc., I asked permission to make a survey of the plant, which was given.

After sizing up the plant in general, I started to check up on the dampers. There were five 5,000-sq.ft. water-tube boilers, forced-draft stokers, individual dampers on each boiler uptake and one main damper in the breeching near where it entered the stack, and individual dampers in the forced-draft duct. I also noticed that there was no draft gages in use. I then asked the chief if he could make a connection for a draft gage (I always carry one with me) on the boiler side of the main breeching.

I next tried the uptake dampers in each boiler to see if they worked easily. The first three I tried were stuck tight; I could not move them even with a 48-in. pipe wrench. No. 4 damper moved about one-quarter of its full distance. No. 5 was either burned off or it had rusted away.

After finding out that there was no regulation possible with the individual uptake dampers, I asked the fireman on duty how he controlled his steam pressure. He said, "By regulating the main damper."

The fireman then walked over toward the chain hanging from the main damper, and I followed. He pulled on one of the chains to close the damper (the steam being high). I looked at the draft gage, which had been connected in the meantime, to see what change was made in the draft and was surprised to see no change. I checked up on the draft gage and then changed the position of the damper myself. It was surprising how much the damper had to be moved before we got any change in draft. Of course, the conditions in this plant were the worst that I have ever encountered.

In conclusion I would like to add that if you are contemplating the installation of a new boiler or a boiler room, don't forget the importance of the dampers. If you already are operating a boiler room, check up on your dampers, see if they move freely, if they are not rusted or burned off from non-use. Install a draft gage near each damper so that when you move the damper, you can see the draft change. If the damper sticks when the boiler is on the line but is free when boiler is off the line, it means that it fits too tightly. All rivet heads around the dampers should be flattened on the inside of the breeching. Instruct the fireman in the use of the damper and emphasize the importance of proper operation.

J. J. NEVILLE.

Chicago, Ill.

Taking Air Temperatures in Blast Heating

IN THE fan-blast heating systems in our buildings the tempered air chambers were provided with angle thermometers installed as shown at *T*, Fig. 1. Here *C* represents concrete foundation piers about 4 ft. high, across which the heaters were placed, and *A* represents the sheet-metal housing forming the tempered air chamber. The thermometer *T* had been placed back of the pier, where it gave unreliable indication of the temperature of the air. To correct this condition, the following changes were made:

A long nipple *D* was prepared, with a reducing elbow on one end and a coupling with a close nipple and washer on the other end. This arrangement is shown enlarged in the sketch. The combined length was sufficient to carry the reducing elbow well beyond the pier. The close nipple was passed through the housing *A* from the inside, where the thermometer had been. Upon the outer end of the close nipple was placed a washer and a tee was screwed onto it, clamping the whole to the housing. The branch opening of the tee was turned downward and left open. The reducing elbow was turned so that the larger end faced the incoming flow of tempered air.

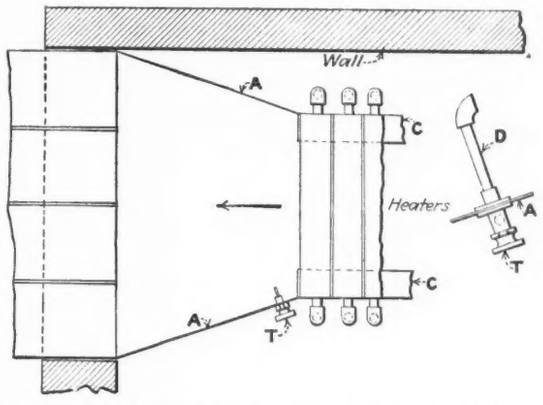


Fig. 1—Method of correcting sheltered location of thermometer

The angle thermometer was then screwed into the open end of the tee, so that as the tempered air flowed out the branch of the tee over the bulb of the thermometer, the proper temperature was indicated.

In another place the heated air passed downward through a tunnel under the floor to another building, as indicated in Fig. 2. The ducts were divided horizontally with the tempered air in the lower duct. To get the temperature of the air in the lower duct, we passed a

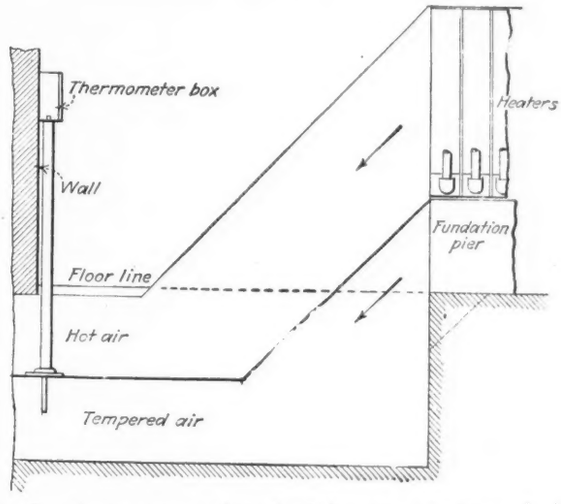


Fig. 2—Arrangement for obtaining temperature of air in an inaccessible duct

2-in. pipe downward through the hot-air duct and rested it upon the partition between the two ducts. A smaller pipe was passed down through the larger one into the tempered air duct, with the upper end of the pipe opening into a thermometer box on a partition wall. This box has a glass door for observation and a hole in the top through which the tempered air escapes after passing over the bulb of the thermometer in the box. With this device accurate temperatures are obtained.

Elgin, Ill. W. L. PARKER.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Why Scrape a Bearing to Fit?

I HAPPENED to be looking over some copies of *Power* the other day, and in the July 24 issue I noticed the article by Charles J. Mason, entitled "Why Scrape a Bearing to Fit?" In this article Mr. Mason makes some rather startling statements. For example, he says: "I am satisfied from personal experience and observation that it is unnecessary to resort to scraping after the bearings have been properly machined, especially in the case of bearings that are lined with babbitt." I am wondering if Mr. Mason has ever seen a turbine rotor fitted and scraped into its bearings, or a Diesel-engine crankshaft, and similar types of journals that require accurate bearing surfaces and should be scraped into their babbitt-lined bearings with a high degree of accuracy?

A little farther on we read: "The old-fashioned idea was to bore out a bearing a trifle smaller than its journal and then scrape it to fit until it crowned. Why not bore it out a trifle larger so that it will crown right away?" he adds. Then he goes on to say how successful this method was on a Corliss engine. This may be all right for quantity production manufacture, but not for modern high-speed prime movers in present-day power plants.

One more point—Mr. Mason says: "There have been cases in which babbitt-lined bearings have been 'run-in' without either boring them out in a machine or using a scraper on them, and good results secured." From my experience in work of this kind I am surprised that he was able to get away with it. W. G. FORBES.

New York City.

* * * *

Costs of Preparing Powdered Coal

AN EDITORIAL in the Oct. 23 issue refers to the use of preheated air in unit mills for the purpose of insuring uniformity of feed. An installation that has now been in operation for more than a year, makes use of partly preheated air and partly waste gas which has eliminated all difficulties incidental to the use of wet coal.

This installation consists of two horizontal water-tube boilers, each fired with one pulverizer, the setting having a flat floor and solid front and side walls, the rear wall being double with 4-in. air space. Two ordinary chimney-tile flues connecting with the bottom of the air space were carried under the furnace floor to each pulverizer in the belief that air drawn down through the rear wall and under the floor would be sufficiently heated to prevent clogging in the pulverizer. The temperature realized, however, was not sufficient to insure successful operation with very wet coal, and to correct this difficulty a 10-in. galvanized pipe was run from the top of the setting, immediately above the circulating tubes, to the air intake of the pulverizer, mixing with the fresh air through the original passage. This eliminated any clogging, and there has not been any interruption to continuous service since this plan was adopted.

Industrial plants do not have a sustained boiler load for any great length of time, and in this installation, at least, neither hollow walls nor water-cooled walls were justified. In a fifty-hour week it is seldom that the average load is maintained for more than five hours so that furnaces do not reach a destructive temperature. In this particular installation the average load is about 150 per cent of rating with occasional loads of 200 per cent, and there has been no apparent deterioration in the setting and no trouble whatever with either pulverizers or burners. A CO_2 of 13 per cent is maintained almost constantly. The amount of waste gas used is so small compared with the total amount of air used in the furnace as to have no apparent influence on combustion, and the cost of the waste gas ducts was negligible.

Incidentally, the two boilers in this installation have replaced twelve hand-fired boilers and the reduced cost of operation, all factors considered, has fully justified the investment. WARREN B. LEWIS.

Providence, R. I.

* * * *

Computing Areas of Openings of Valves

IN HIS comment on "Another Method of Computing Areas of Irregular Shapes," in the Oct. 30 issue John Mocine presents a method that is interesting and entirely new to me and has, for approximate estimations, some advantages over the method I presented in the July 31 issue, using the cross-section paper and counting squares.

The disadvantage is the accuracy of the scales used in weighing the cut-outs, the uniformity of weight of the paper, and the accuracy in cutting out the shape. The required scales are not available to the man in the drawing room, whereas the paper is always obtainable.

The results obtained by Mr. Mocine check very well, so that the method is worth attention.

Going in the reverse direction, to obtain the value of the area of the lunar opening of the valve by simple mathematics, using the areas of the sectors and segments of the circles involved, the formula has this formidable aspect:

$$Area = \left[\frac{360\text{-}angle\ \theta_1}{360}(\pi r_1^2) + y\sqrt{r_1^2 - y^2}\right] - \left[\frac{angle\ \theta_2}{360}(\pi r_2^2) - (c - y)\sqrt{r_2^2 - (c - y)^2}\right]$$

The sub-figures 1 refer to the valve body circle, while the sub-figures 2 refer to the valve gate circle. This formula is so long that the meanings of the terms are not given. The derivation will be given if requested.

The point I wish to make in presenting this formula is the value of short-cuts such as the two mentioned by counting squares or weighing the paper cut-outs.

Not only is there a lot of labor saved, but the possibility of error in using the formula is great, so that no greater accuracy may result in its application. Then look at the training necessary to use the formula.

Pittsburgh, Pa. L. G. JONES.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Type "C C S" Close-Coupled Centrifugal Pumps in Single- and Two-Stage Types

A LINE of close-coupled centrifugal pumps in the single- and two-stage types, designated as type "CCS" series 6,000, has been added

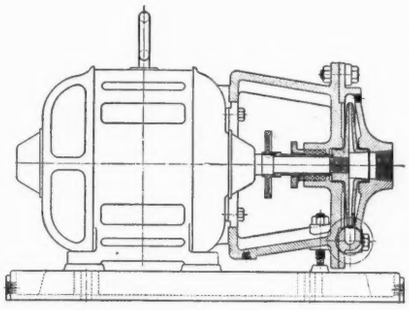


Fig. 1—Single-stage motor-driven unit

to the line put out by the Aldrich Pump Company, Allentown, Pa.

The new line, which is fitted with a closed-type impeller designed to give higher operating efficiencies than that of the open-type impeller, is available in three models: Single-stage motor-driven, as shown in part section, Fig. 1; two-stage motor-driven, Fig. 2, and the single-stage turbine-driven unit, Fig. 3. The design of the pump is the same in each

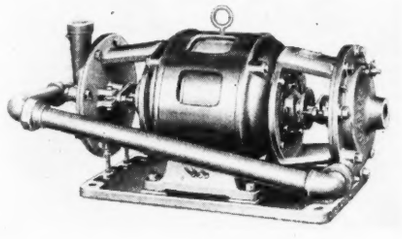


Fig. 2—Two-stage unit with impeller mounted on ends of motor shaft

case, the impeller being mounted directly on the end of the motor or turbine shaft and the pump supporting casing bolted to the motor end bell or to an extension flange on the turbine bearing. Each unit is self-contained and is mounted on a drip bedplate extending under both pump and motor. The bedplate is tapped at each end for the drain connection.

In the design of the pump shown in section, Fig. 1, the casing is of semi-steel with the volute passages machined to reduce the friction. The suction and discharge connections are screwed on the 1½-in. size and flanged on the 2-in. size. The impeller is of government bronze with the outside surfaces polished and the inner surfaces filed smooth. A bronze sleeve protects the shaft through the stuffing box, and a splash disk is provided on the shaft to prevent any leakage from the stuffing box entering the moto bearing. This disk also serves as a handwheel to test the free running

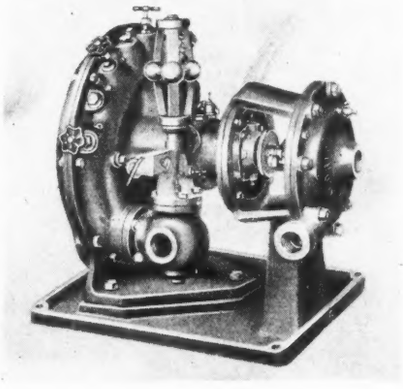


Fig. 3—Turbine driven unit with governor

of the rotating element. The stuffing box is of ample depth, and no water seal is used. Ball bearings are used in the motor, and these take care of any slight end thrust developed by the pump impeller which is hydraulically balanced.

The new line is available in two sizes, 1½-in., with capacities from 20 to 100 gal. per min., and 2-in., with capacities from 100 to 160 gal. per min. In addition to being adaptable to a large variety of services, units of the type CCS pump are available with inclosed motors for handling inflammable liquids, such as gasoline, benzol, etc.

K & S Pocket Radiation Pyrometer for High Temperatures

THE fundamental principle on which the radiation pyrometer, illustrated, operates is the measurement of the radiant energy emitted by a hot body whose temperature is to

Fig. 1—"Total radiation" type pyrometer

be determined. Referring to Fig. 2, at the focus of a collecting lens having a diameter of 1⅛ in. and a 2-in. focal length is located a bimetallic spiral of about 0.1 in. diameter and 0.001 in. thickness. A pointer, joined to the spiral, which moves in front of a scale divided in temperature degrees, permits observing the change of the spiral. In order to obtain the highest possible sensitivity of the instrument, the spiral is fastened to a stretched wire 0.002 in. in diameter, and behind the latter a small concave mirror is placed.

With the practicable use of the

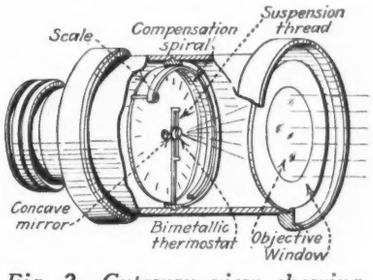


Fig. 2—Cutaway view showing pyrometer movement

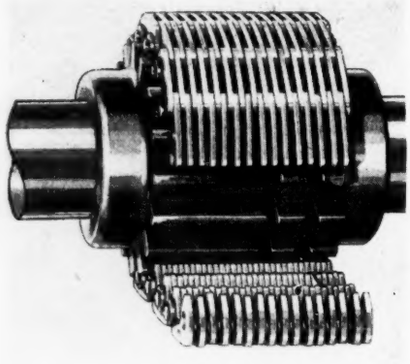
radiation energy, the heat absorption is extremely small. The spiral attains a considerable temperature even with low radiation and indicates within a few seconds the heat intensity investigated. In order to compensate for variations of room tem-

peratures, the scale can be turned, and its momentary position relative to the pointer is automatically regulated by a compensation spiral. The scale is transparent and can be seen at the same time the glowing surface is viewed through the ocular, enlarged about eight times. To protect the eye against the bright rays when measuring high temperatures, a red glass is provided to place between the eye and the ocular.

The instrument has a distance factor of about twelve; in other words, the distance from the instrument to the furnace opening or piece of material whose temperature is being measured, should not be more than twelve times the diameter of the opening or piece. All working parts of the instrument are completely inclosed and protected in a dustproof housing. The over-all dimensions are 6 in. long and 2 in. in diameter, and the weight is approximately 6 oz. Five scale ranges are available from 1,100 to 2,600 deg. F., to 1,100 to 4,000 deg. F., and from 600 to 1,400 deg. C. to 600 to 2,200 deg. C. This instrument is put out by the Colonial Supply Company, 217 Water St., Pittsburgh, Pa.

Silent-Chain Type Flexible Coupling

THE flexible coupling illustrated, put out by the Morse Chain Company, Ithaca, N. Y., consists primarily of a silent chain wrapping two sprockets, each one-half the width of



Coupling with chain opened to show sprockets

the chain. One sprocket has a guide groove in the center of its face to hold the chain in place. The other has no guide grooves and is free to float under the chain, which is loose enough on the sprockets to take care of ordinary misalignment.

Improved Carbide Light

THE illustration shows a carbide light or generator designed to operate with either lump carbide or carbic cakes. The center of the carbide container is a cylinder which holds the carbic cakes and which has facilities for taking care of the sludge. The outside of the container is fitted with conical pockets for the ordinary carbide.

This dual fuel principal is incorporated in single lights of 8,000 and 12,000 cp. and in the duplex light of 16,000 cp. In the new generator some of the important features of the

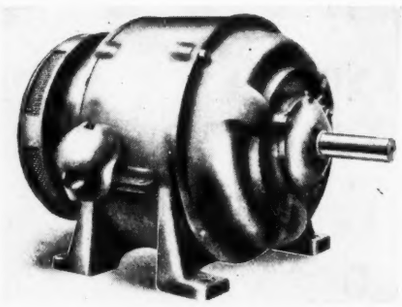
Light uses either lump carbide or carbic cakes

former types have been retained, as follows: It cannot be overcharged, can be recharged without changing the water, and has an automatic cleaner for cleaning the burner.

This generator is a recent addition to the acetylene lighting and welding equipment put out by the Alexander Milburn Company, Baltimore, Md.

Air-Cooled Skeleton-Frame Induction Motor

IN THE air-cooled skeleton-frame induction motor illustrated, a radiating bonnet is used to inclose completely the motor stator independently of the outer casing. The inner edge of the radiating bonnet is clamped tightly between the bearing housing and the inside bearing cap, and the outer edge is sealed by fitting the bonnet into a machined surface in the stator frame. This construction provides a tight and stationary seal and protects the air gap between the stator



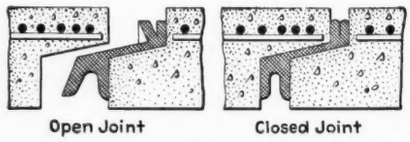
Skeleton-frame induction motor

and the rotor from dirt and dust. The ball bearings are also inclosed and protected against dirt.

Cooling air is drawn through openings at the center of the coupling end bearing bracket, passed over the radiating bonnet of the stator and exhausted by a large-diameter fan on the outer end of the shaft. The skeleton-frame motor is interchangeable in all mounting dimensions, but limiting dimensions exceed those of the open-frame sizes at the front end only by the amount necessary to allow for the external fan, which is inclosed by a substantial housing. The electrical and operating characteristics of this motor, which is being put out by the Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio, are the same as for those of an open type. The sizes available range from $1\frac{1}{2}$ to 40 hp. for operation on 220, 440 and 550 volts, two- or three-phase 60-cycle circuits.

Watertight Rubber Joints for Concrete Pipe

A JOINTING material of the cross-section shown in the accompanying illustration and made of india rubber, has been developed



Section of rubber joint in open and closed position

by a French engineer, Leon Bille, 45 Grande-Rue, Nogent-sur-Marne (Seine), France. It will be noted

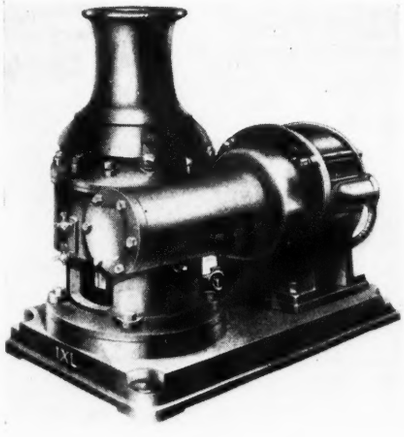
from the accompanying illustration that when in the installed position the water pressure against the joint tends to tighten it against the walls of the pipe.

The joint is claimed to be watertight both with and without pressure. In addition, it affords the pipe line a considerable amount of flexibility without developing leaks. M. Bille points out that the pipe can be laid under water without difficulty. Under all sorts of laying conditions the pipe is installed by merely pushing one pipe into the other. The outside of the joint can be filled with asphalt or concrete and if necessary a concrete collar can be poured around the joints. Although primarily designed for use with concrete pipe, it is claimed that this joint is also adaptable to cast-iron, steel or wood pipe.

"IXL" Motor-Driven Car Spotter

THE motor-driven car spotter illustrated, made in two sizes, having a rope pull of 3,000 and 6,000 lb. and requiring a motor of 5 and 10 hp. respectively, has been brought out by the Foote Bros. Gear & Machine Company, 213 N. Curtis St., Chicago, Ill.

The reduction unit used in the construction of the spotter is the stand-

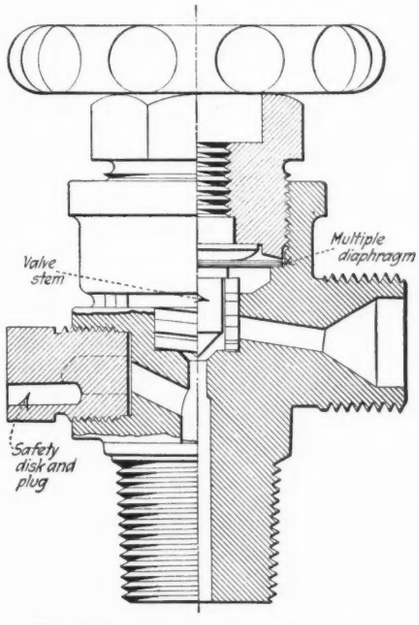


Car spotter unit

ard Foote vertical worm-gear reducer, and the motor is connected to the worm shaft through an inclosed spur-gear drive. All gearing is inclosed in a dust-proof oiltight case, and lubrication is obtained by splash from the gear. The worm gear is made from chilled cast bronze, and the worm is made from nickel steel carbonized and hardened. Ball and roller bearings are used to take care of radial and thrust loads. The capstan is of cast iron, machined and keyed to the vertical shaft of the reduction unit. The units are available with or without motor, as desired. The entire unit is completely mounted on a cast-iron bedplate with cushions provided for mounting the motor and with lugs and bolt holes drilled for mounting on a concrete base.

Packless Valve for Compressed Gases

A NEW packless valve for use with compressed gases, such as ogygen, hydrogen, nitrogen and air, is shown in the illustration. The



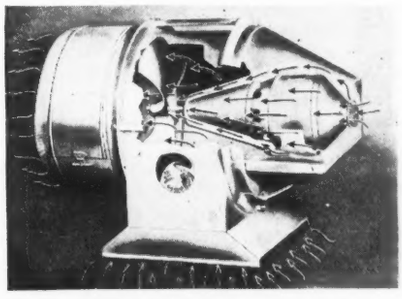
Partial cross-section of packless valve

usual packing is replaced by a multiple diaphragm held between a shoulder in the body and the valve bonnet. A short valve stem is attached to the lower side of the diaphragm and a screwed stem is made to press down on the top, sufficient movement being allowed to close the valve by pushing the diaphragm downward. The valve body is of forged brass.

A safety feature is incorporated consisting of a frangible disk backed by fusible metal which will melt at 212 deg. F and release at 2,600 to 2,800 lb. pressure. The valve is available in the $\frac{3}{4}$-in. pipe size. It is a recent development of the International Oxygen Company, Newark, N. J.

Explosion-Proof Ventilating Unit

IN THE explosion-proof ventilating unit illustrated, designed for use with air finishing booths and similar services, a universal mounting and housing provide convenience in



Assembly of ventilating unit

erection and make the unit adjustable for four mounting positions, so that the outlet connection can be made in the most convenient place. The motor is fully inclosed and is located outside of the path of the fumes, air being passed over the motor casing as shown in the illustration. The three-blade aluminum fan is designed to handle a large volume of air per horsepower and can be cleaned or removed without disassembling the motor.

The ventilating unit is made in four sizes, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 hp., giving, respectively, displacements in cubic feet of free air per minute of 2,700 to 3,200, 2,250 to 5,000, 8,000 to 10,000 and 14,000 to 16,000. The motors available operate on 220-, 440-volt, two-phase circuits, 110- to 220-volt single-phase circuits, and 110-220 volt direct-current circuits. The unit is put out by the Paasche Air Brush Company, 1909-27 Diversey Parkway, Chicago, Ill.

Semi-Steel Pulley

IN THE line of metal pulleys the cast-iron and pressed-steel types have become more or less standard. A new addition to the line is the semi-steel pulley announced by the W. A. Jones Foundry & Machine Company, 4401 West Roosevelt Road, Chicago, Ill. Among the advantages claimed for this new pulley is that for a relative size and weight, as compared with cast iron, a closer-grained and better-looking pulley is obtained and one that is especially well suited for a sharply fluctuating load.

Which of Several Bids Should Be Accepted?

F. M. Van Deventer, of H. L. Doherty & Company, gave the paper that is here abstracted before the second annual National Fuels Meeting of the American Society of Mechanical Engineers, held in Cleveland, Ohio, Sept. 17 to 20, 1928.

AS THE major equipment used in the power plant is becoming more and more highly developed, the selection of such equipment becomes a more complicated and important function of the engineering and purchasing departments.

By way of a generalized outline it may be said that the several steps involved in the placing of a contract, as practiced by major companies, are as follows:

(*a*) The engineering department, having determined the size, type and general characteristics desired in the equipment, prepares a specification covering these data and other essential and supplementary information.

(*b*) The purchasing department submits the specifications to the various manufacturers from whom bids are desired, with a formal request for proposals.

(*c*) The manufacturers submit to the purchasing agent their formal proposals. These proposals embody a bid price (or set of prices for various combinations of equipment), tabulations of the operating characteristics of the equipment under conditions stated in the engineers' specifications, and they either accept the purchaser's specification (with or without exceptions) or embody a complete specification in detail covering the particular equipment offered.

(*d*) The engineering and purchasing departments confer and concur in a decision concerning which bidder offers the equipment which is the most desirable. A formal contract is then executed between the purchasing agent and the manufacturer.

While the foregoing outline is general and brief, many variations in the method of procedure for the individual steps are practiced by different companies. For example, a popular and satisfactory method of handling step (*d*) is more specifically as follows:

(d_1) The purchasing agent, upon receipt of proposals, detaches price data from engineering data, filing the former and referring the latter to the engineers.

(d_2) The engineers, uninformed concerning prices, scrutinize the proposals carefully, to determine the relative value of the several proffers, noting credit or debit for superior or inferior characteristics, respectively. As a result of this study a figure is deduced for each proposal, expressed in dollars, which, when added to the bid price, gives a figure that represents the compensated cost price, all tangible factors considered. For convenience the sum of the compensating figures may be called the "compensating index," and when added to the cost price, the result may be called the "compensated cost index." The latter is inversely proportional to the economic value of the various proffers.

(d_3) The purchasing agent, preferably in conference with the engineers, combines the price data and the compensating indices, and obtains the "compensated cost index."

Various Criteria of Value

The various data most commonly used in comparing the relative worth of proposals are:

1. Lowest first cost.
2. Lowest first cost per unit of surface, unit of capacity, etc.
3. Lowest first cost per pound of material.
4. Highest efficiency or lowest fuel cost.
5. Highest rate of return on investment.
6. Shortest time required for fuel saving or net saving to equal first cost.
7. Highest net saving, or minimum production cost.

Each of the foregoing will be briefly discussed in the following paragraphs:

1. Lowest First Cost—If the various tenders were on a par so far as operating characteristics and general suitability are concerned, the choice would obviously be the one embodying the lowest bid price and consequent lowest carrying charges. In purchases for municipal works an attempt is usually made to prepare specifications in such form that all bids will cover identical work or materials. Tenders are then sealed by bidders and opened in public, the contract being awarded to the lowest bidder. The design of power-plant equipment, however, is largely affected by patents, basic designs, standards, use of existing patterns or dies, etc. As a result, tenders are seldom on a sufficiently common basis that bid price alone is a suitable criterion. Not infrequently, it is found that the equipment with highest first cost has sufficient merit over all others to render it the most desirable one economically. Therefore, while it is desirable as a general proposition to minimize the over-all plant cost, equipment cannot logically be purchased on that basis, since it is probable that while the carrying charges would be minimized, operating costs would be sufficiently high to more than offset the saving in carrying charges.

2. Lowest First Cost per Unit of Surface, Capacity, Etc.—While the specifications may call for an equipment of a given nominal size or capacity, it often happens that the design of one bidder's equipment permits the carrying of greater overloads than others. Such marginal capacity should be evaluated and credited in the setup. However, while "dollars per square foot" or "dollars per kilowatt," etc., gives an indication of the relative cost per unit of size, selection should not be made on this basis alone.

3. Lowest First Cost per Pound of Material—This is obviously not a criterion of *value* and should not be used for selection. However, if two designs are sufficiently alike that machine work and fabrication are relatively identical, an excessive price per pound indicates that the marginal cost of the higher bid goes to excessive overhead or profit to the manufacturer, and that no corresponding value will accrue to the purchaser. This datum is therefore one of secondary importance in comparing bids.

4. Highest Efficiency or Lowest Fuel Cost—This datum is undoubtedly more commonly misused than any other. Maximum efficiency is, of course, desirable, but not at the sacrifice of excessive costs unaffected by efficiency. It may safely be said that any existing or proposed plant or component piece of equipment could be designed for higher efficiency, but in most cases, although fuel expense would be less, the actual cost of producing energy would be higher, because of excessive fixed charges. The importance of these charges may be emphasized by pointing to the fact that in the average plant fixed charges exceed fuel cost by a considerable margin. Therefore, in design practice efficiency is of secondary importance to first cost.

5. Highest Rate of Return on Investment—The fallacy of the use of this datum undoubtedly results from considerations of personal investment. If one has a definite sum of money to invest, it is natural that he should seek the highest rate of return, since that is a true measure of the value of his investment (ignoring the element of security, etc.). From this fact it is often erroneously concluded that in the case of competitive bidding the best proposi-

tion is that which yields the greatest return on the investment. This is not a true rule, and its use cannot be depended upon to indicate the best selection.

6. Shortest Time Required for Fuel Saving or Net Saving to Equal Cost—This datum is the inverse of "return on investment"; and since the same limitations apply to it, it should not be used in rating the merits of competitive bids. It is often desirable to compute this datum or the rate of return on the investment, in order to determine whether the savings on a proposed investment are of sufficient magnitude to render it attractive, but it gives no reliable *relative* evaluation of alternatives.

7. Highest Net Saving or Minimum Production Cost—This datum is the proper one for the evaluation of bids or for economic studies to determine the optimum arrangement of equipment. Since all costs incidental to the production and delivery of energy may be classified as either fixed charges or operating charges, it is obvious that the most desirable combination and arrangement of equipment is that which renders the sum of these costs a minimum.

The setup for each proposition may be made by determining the sum of the annual outlay for fuel, operation of auxiliaries, etc., and the fixed charges on the first cost of the equipment.

An alternative method, which is more convenient in the application of steps (d_2) and (d_3) previously outlined, uses capitalized values. The amount of fuel required annually to operate the plant with the proposed equipment is determined and capitalized at the fixed charge rate properly applying to the project or to the particular piece of equipment under consideration. The annual cost of operating dependent auxiliaries and other annual costs requiring data constitutes the "compensating idex" determined by the engineers. The purchasing agent then has merely to add the bid price to determine the "compensated cost price." The proposition for which the compensated price is a minimum is the economic choice.

If the equipment under consideration is of a supplementary nature, such as economizers, air preheaters, or extraction feed-water heaters, added to enhance over-all thermal economy, a parallel setup may be made on the plant without such equipment. Then the difference between the compensated cost index of any setup and the index for the setup without such equipment is the capitalized net saving due to the proposed equipment. The proposal which indicates maximum net saving is the economic choice, and this datum will coincide with minimum "compensated cost index."

RECENT PUBLICATIONS

SNAPSHOTS OF SCIENCE. By Edwin E. Slosson. The Century Company, New York, 1928. Cloth; 5x7½ in.; 299 pages; illustrated. Price, $2.

"The time has come, the walrus said,
To talk of many things;
Of shoes, and ships, and sealing wax,
Of cabbages and kings."

CURRENT magazines have been full of advertising regarding the social success of a certain young man who could talk interestingly on a vast variety of subjects. It is guaranteed that one thorough reading of Doctor Slosson's book will provide enough talking matter to last through hundreds of bridge rubbers. Of course, like the young lady who lisped, it might prove as difficult to introduce one of these subjects as she found the use of the one sentence she could say correctly, "Sister Susie's sewing shirts for soldiers."

On the other hand, looking at the book from a gustatory angle, the only difference between eating a Swedish dinner and reading "Snapshots of Science" is that after completing a full round of Smörgasbord, one has no room or desire left for the real food, while after reading all the various essays on matters geological, geographical, genealogical and ethnographical and, well—"scientifical," one resolves to read some of the books listed in the very complete bibliography printed in the back of the volume.

It would be unfair to the reader (for I'd spoil them in the telling) and to the author (because he'd lose his royalties on the sale of the book) to relate all the stories contained in this book, but a few should whet the appetite.

On page nine mention is made of the Roman Anita Loos who had such a profound hold on her feminine audience that the demand for the hair bleach used by the blond Gauls caused the introduction of soap into Rome, for soap was originally a hair bleach, according to Pliny.

Babe Ruth may not know it, but he probably has found a proper retort to the "Magnus" principle, which physicists tell us makes baseballs curve.

Soon the old stunt of sending the apprentice for a left-handed monkey wrench will be superseded by sending for a pound of left-handed sugar, but the joke will be on the joker, for the boy will bring it back, if the laboratory results of the Bureau of Standards in making sugar from Jerusalem artichokes (which are not artichokes at all) can be carried out successfully on a commercial scale. (Editor's Note—Left-handed sugar is a facetious way of saying sugar which bends polarized light to the left. It is considerably sweeter than dextrose, the right-handed sugar.)

It is too bad to think of the possible passing of that quaint custom of milking cows. However, cowless countries may some day milk the soy bean, which will yield ten times as much lacteal fluid as would cows eating the fodder planted on the same amount of land that produced the beans.

These and many other equally interesting items are to be had for the reading of this one-volume encyclopedia of what is doing in the world of science.

HOW TO BEGIN THE APPLICATION OF ARC WELDING IN PRODUCTION MANUFACTURING (Supplement to "Arc Welding—The New Age in Iron and Steel"). Published by the Lincoln Electric Company, Cleveland, Ohio, 1928. Paper, 5x8 in.; 32 pages; 42 illustrations. Price 50 cents, but distributed without charge to present owners of "Arc Welding."

It is evident that a real revolution in machine design and construction is under way. Replacement of castings and rivets by welded construction is making rapid progress. The importance of this little book arises largely from this condition. While the fundamental principles of the mechanics of materials have not changed, designers brought up in the old school must rid their minds of many notions regarding the proper form of machine parts and assemblies. Welding calls for a new approach to the design problem, a building up from first principles with the possibilities of the new method of fabrication in mind. The illustrations in this book show how the various units of welded design are handled, with particular emphasis on frames and bases. The treatment is nonmathematical and will be understood without difficulty by any man who designs or builds machinery. While the book stresses production welding, the methods shown are entirely applicable to special frames, bases and other parts which must frequently be built under the supervision of the power engineer.

METHODS OF TEST RELATING TO ELECTRICAL INSULATING MATERIALS—A special reprint pamphlet that has recently been issued, covering the testing of insulating materials. It contains all the methods of testing insulating materials prepared by the American Society for Testing Materials committee on electrical insulating materials and the annual report of the committee presented at the June meeting of the society at Atlantic City, N. J. In addition it contains some specifications prepared by other committees of the society of interest in connection with electrical insulation. The pamphlet will provide a handy reference publication for those interested in the methods of testing insulating materials. It comprises 155 pages and is now available for distribution. The price of the pamphlet is 85 cents per copy. Orders should be adressed to the society at 1315 Spruce St., Philadelphia, Pa..

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Greatest Welsh Station Complete

Third of Series of Hydraulic Plants in South of England Opened—Initial Installation of 22,500 Kva.

WITH the recent formal opening of the great dam, constructed in connection with the North Wales Power project, an undertaking of national significance was inaugurated in Great Britain. The dam is located in the Vale of Festiniog.

The dam and works are near Maentwrog and constitute the third of the hydro-electric generating stations of the North Wales undertaking, and besides being the largest, has been planned for the requirements of 60 years hence. Surveys were made at Maentwrog immediately after the issue of the North Wales and South Wales Electricity Order in 1923, and the construction of a dam for the waters of the River Prysor was begun early in 1925. The results of three years' work by 1,000 men are to be seen in the main arched dam 403 ft. long, and in three cut-off dams of 741 ft., 1,711 ft., and 2,500 ft. in length, respectively.

The impounded water covers an area roughly diamond in shape, of 1,274 acres and with a capacity of 1.2 billion cubic feet. The effective head of water obtained at the foot of the high-pressure pipe line at the power station is 630 ft. On leaving the lake the water passes through a main sluice and automatic butterfly valve, by which the flow into the low-pressure pipe can be controlled. This riveted steel low-pressure pipe of 9 ft. 6 in. diameter passes through two tunnels 1,920 ft. and 1,500 ft. long in its course across the hills to the summit of the high-pressure pipe immediately above the power station. Similar valves control the entry of the water to the 6-ft. high-pressure pipe. Space is available to house a second high-pressure pipe in the pipe channel when required for additional power units at the station.

At present the power-house has three three-phase 7,500-kva. turbo-alternators, generating at 6,600 volts, 50 cycles. The turbines are of the double-runner, double-jet type operating at 333 r.p.m. under a head of 630 ft. The voltage is stepped up to 35,000 volts, and to 66,000 volts for transmission to Wrexham and Crewe.

Kenneth M. Clark, chairman of the North Wales Power Company, said that the cost of the works was approximately £1,000,000 ($5,000,000), and of the transmission and distribution system another £1,000,000.

One striking feature of the development was the result of a condition of the sale of the land, requiring that all pipe-lines down the mountain side and all buildings should be surrounded with large trees to avoid disfiguring the landscape of the beautiful valley. Some trees have already been planted, and within a year the whole area will be covered with them. An old Roman bridge running through the power station land has been preserved.

Iron and Steel Electrical Men Hold Meeting

At the Philadelphia section meeting of the Association of Iron and Steel Electrical Engineers, held at the Philadelphia Engineers Club, Saturday evening, Nov. 3, the opinions expressed showed that synchronous motors were reliable power drives for applications that only a few years ago were not even considered for this type of machine. H. H. Angel, general foreman, electrical department, Bethlehem Steel Company, Sparrows Point, Md., presented a paper, "Starting Characteristics of Large Synchronous Motors." In it Mr. Angel described the operation of two synchronous motors driving steel rolling mills.

One of these motors is rated at 4,000-hp., 6,600 volts, 25 cycles, 83.3 r.p.m., he said, and the other at 6,500-hp. for the same voltage and frequency, but operating at 187.5 r.p.m. The 4,000-hp. motor is directly connected to its mill, while the 6,500-hp. motor is gear connected.

Comparative efficiency and power factor figures were given for these motors and wound-rotor induction motors of equal size and speed. At one-half, three-quarters and full load the 4,000-hp. synchronous motor has efficiencies of 91.6, 93.3 and 94 per cent respectively. At full load the power factor is 80 per cent leading. An induction motor of equal rating would have efficiencies of 90.2, 91.8 and 92.5 per cent, respectively, for the three loadings previously mentioned. The power factor at these loads would be 62, 75 and 82 per cent lagging, respectively.

These figures show an advantage of 1.5 per cent in efficiency in favor of the synchronous motor. The induction motor also has the disadvantage of a low lagging power factor compared to the leading power factor of the synchronous motor. The last feature means that considerably larger generator and line capacity would be required to supply power to the induction motor, which should also be included in the higher cost of the induction motor over the synchronous motor.

These synchronous motors are started automatically from a master switch. Two steps of reduced voltage are applied before switching to full voltage. On the second step of reduced voltage the field is applied, which is also energized in two steps. All the different operations of starting are entirely automatic, the only thing that the operator does is to close the master switch to the position that will give the desired direction of rotation to the motor. From stand-still the motor will accelerate the mill to full speed in about 35 seconds, without the starting current exceeding full-load value. The motors are started so smoothly that the power house does not feel the effects.

Considerable discussion centered on the torque required of synchronous motors. The opinion was expressed that application engineers were placing too much stress on high starting torque, instead of considering the problem from the point of view of the torque required by the load. There are three different torques to be considered—starting, pull-in and pull-out. All three of these cannot be made high, but they can be adjusted in the design to give a desired combination for the most satisfactory operation.

Early Stevens Boiler Will Figure in Davis Inaugural

The Smithsonian Institution recently shipped to the Stevens Institute of Technology in Hoboken, N. J., the original boiler and safety valve of the John Stevens locomotive, the first locomotive successfully operated in America, for exhibition at the inauguration of Doctor Harvey N. Davis as President of the Institute on Nov. 23. Colonel John Stevens, who has been called the "Father of American Railroading," first operated the locomotive in 1825 on a circular wooden track, on his estate at Castle Point, Hoboken. The greater part of this estate is now included in the campus of Stevens Institute.

The boiler and valve have been in the Smithsonian Institution for many years, constituting in the museum's collection a unique part of the division devoted to the history of steam. The boiler was of a vertical-tubular design with a grate beneath into which lengths of wood were fed through a hole in the case.

The boiler consisted of a top and bottom header, each header being made in halves and bolted together, and contained twenty 1⅞-in. tubes. The engine consisted of one cylinder five inches in diameter and having a twelve-inch stroke. It was a rack-driven locomotive and power was transmitted to the rack by two gears attached to the frame. Records in the government archives indicate the Stevens locomotive attained a speed of twelve miles an hour, carrying six persons on seats at one end of the locomotive frame.

American Standards Association Succeeds A.E.S.C.

Unanimous approval by the 37 member bodies of the establishment of the American Standards Association to succeed the American Engineering Standards Committee, has lately been announced by William J. Serrill, assistant general manager of the United Gas Improvement Company, of Philadelphia. Mr. Serrill was chairman of the Standards Committee, and now becomes president of the American Standards Association. One of the most important results of the abandonment of the committee form of organization will, according to Mr. Serrill, be a much greater degree of participation by trade associations in the direction of the national industrial standardization movement.

One of the first acts of the association will be the organization of a board of directors composed of twelve industrial executives. This newly created board will control the general administration and policies of the association.

The officers of the association are, in addition to Mr. Serrill: Vice-president, Cloyd Chapman; secretary, P. C. Agnew; assistant secretary, F. J. Schlink. The advisory committee of industrial executives includes: J. A. Farrell, president of the U. S. Steel Corporation, chairman; George B. Cortelyou, president of the Consolidated Gas Company; John W. Lieb, senior vice-president of the New York Edison Company; L. F. Loree, president of the Delaware & Hudson Company; and Gerard Swope, president of the General Electric Company.

New Steam Power Station In Indiana

Rapid progress is being made in the construction of the new steam-electric generating station in the City of Evansville for the Southern Indiana Gas & Electric Company.

This station, located on the Ohio River, will have an electrical installation consisting of one new 12,500-kw. turbine-generator unit with condenser and auxiliaries and one 7,500-kw. turbine to be taken from the Division Street station of the same company. It will contain two 1,160-hp. crossdrum boilers, stoker fired, with economizers, draft equipment, feed-water equipment and other necessary auxiliaries. The boiler room is designed to take care of one additional boiler. Intake and discharge tunnels and screenhouse are designed for an ultimate development of 100,000 kw. Adequate coal- and ash-handling facilities are being provided.

This new Ohio River steam plant, with its 20,000-kw. generating capacity, will be interconnected with the existing Division Street plant by three 12,500-volt tie lines through a modern outdoor substation to be constructed next year.

The concrete foundations are completed to the point where no further trouble is anticipated from possible high water in the river. Structural steel is being delivered and erection started. Steam and electric equipment is well in hand. The construction work is being carried out by Stevens & Wood, Inc., of New York and Evansville. The cost of this plant is estimated at $1,750,000 and it will be in service in August, 1929.

New England Power System Makes New Output Record

The New England Power Association system has established a new high output record by producing in a single day over five million kilowatt-hours of electric energy. The extraordinary growth of the system is well illustrated by contrasting its present output, which is running at the rate of over one and one-half billion kilowatt-hours a year, with that of 1910, when the output for the entire year was equal to no more than seven days' peak production of the present system.

The Fifteen Mile Falls hydro-electric development, when completed, will add half a billion kilowatt-hours to the present annual output of the system.

High-Voltage Current Makes Steam in Sweden

Experiments for the purpose of generating steam from high-voltage electric current (50,000 to 80,000 volts), that may open the possibility of utilizing surplus energy of waterfalls to good advantage, are being carried on under the auspices of the Swedish Institute of Industrial and Engineering Research.

It is reported that the trials so far carried out, although in a preliminary stage, have yielded interesting results. The electric boilers now in use cannot employ a higher tension than 30,000 volts, but if the costly transformation from the customary transmission-line voltage can be avoided, this mode of generating steam will prove remarkably cheap, it is declared. Pulp mills, which are very large consumers of steam, would in many cases benefit by the proposed arrangements, it is said.

THE WORLD'S LARGEST FLOATING DERRICK lifting the rotor of the largest of all frequency changers at Albany, N. Y. These rotors were shipped on Sunday because only on that day could the necessary three-track right of way be obtained by rail. Their journey started from the General Electric factory at Schenectady, they were transshipped at Albany and will be delivered by barge to the Waterside Station of the New York Edison Company in the Metropolis. The pair will contribute nearly 110,000 hp. to the interchange of 25- and 60-cycle power.

Arthur Williams Resigns

Arthur Williams, vice-president of the New York Edison Company, in charge of commercial relations, recently announced his resignation of that office in order that he may have more time to devote to his numerous outside interests.

Mr. Williams' resignation follows an association with the New York Edison Company which covers a period of almost 45 years. For a long time he has been a national figure in the activities of the electrical industry, and his contributions to the progress of its various branches have won frequent recognition. In the course of his career he has been president of the National Electric Light Association, the Association of Edison Electric Illuminating Companies, the New York Electrical Society and the New York Electrical League. He is at this time president of the Electrical Show Company, under whose direction the annual New York Electrical and Industrial Exposition is held, and of the New York Electrical Board of Trade.

Born in Norfolk, Va., 60 years ago, and educated in New York City, Brooklyn and Hartford, Arthur Williams was as a youth attracted by the dawning possibilities of the electrical art and on leaving school became identified in 1884 with Rennie & Smith, wiring contractors for the old New York Edison Electric Illuminating Company. Early the next year he entered the service of the Edison Electric Illuminating Company.

He was closely connected with electrical history as it was made in the old Pearl Street station in the City of New York, the starting point of the electric lighting industry in America. Serving successively as superintendent of interior construction, electrician, superintendent of the third district, superintendent of the underground department and general inspector, Mr. Williams was appointed general agent in 1893 and in 1915 was promoted to be general commercial manager. In 1924 he became a director of the New York Edison Company and vice-president in charge of commercial relations.

Oregon Project Planned

The Northwestern Electric Company, Portland, Oregon, has active negotiations under way for a large power development on the Lewis River in Cowlitz County, Washington. Extensive purchases of land in this district have been made recently by the company, and agreements have been entered into with the county commissioners, by which the company agrees to pay $100,000 for construction of a new highway to replace the present Lewis River road, which will be flooded by the lake to be created by the power dam.

The dam will be a short distance below Ariel and about twelve miles above Woodland. Representatives of the company have stated that work on this development will continue as fast as possible, the first unit probably reaching a cost of $5,000,000.

Coming Conventions

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Society of Heating and Ventilating Engineers, 35th annual meeting, Chicago, Ill., Jan. 28-31, 1929. A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, annual meeting, in New York City, Dec. 3-7. Calvin Rice, secretary, 33 West 39th St., New York City.

American Society of Refrigerating Engineers, at New York City, Dec. 2-6, 1928. David S. Fiske, secretary, 37 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-24.

Naval Architects and Marine Engineers to Meet

The thirty-sixth general meeting of the Society of Naval Architects and Marine Engineers will be held in the Engineering Societies Building, 29 West 39th St., New York City, Thursday and Friday, Nov. 15 and 16. In addition to a paper on "The Scientific Application of Welding to Ship Construction" at the first session, there will be several papers on fuel burning under marine boilers, and on other subjects of interest to readers of *Power*, to be given during the second session by naval men and others of prominence. The secretary of the society is D. H. Cox, 33 West 39th St., New York, N. Y.

Ohio Edison Plant Capacity Increased

No. 4 turbine-generator of the Toronto plant of the Ohio River Edison Company, operated by the Pennsylvania-Ohio Power & Light Company, has just been placed in operation.

The new unit of this power plant adds 37,500 kva. to its capacity, making the total capacity 150,000 kva., equal to about 175,000 hp. This is just one-half the planned ultimate development.

The generating unit is complete in every detail, but the additional boiler installation will not be completed before the end of this year.

The Toronto plant was designed and constructed by Stevens & Wood, Inc., New York and Youngstown, and has cost to date with all facilities about $16,000,000.

Wisconsin Utility Plans New Projects

The Wisconsin Light & Power Company recently purchased from the American Tar Products Company its Rock River dam at Rockton, Wis., and, it is understood, will erect a huge hydroelectric plant at the site. The property includes the dam, mill race and 230 acres of land. Poles have already been erected for high power lines leading to Roscoe and adjacent points. The Wisconsin company, it is said, has also acquired sites in northern Illinois, eastern Iowa and southern Wisconsin for other similar projects, planning development of huge water power supply sources.

OBITUARY

RICHARD DEVENS, engineer associated with the Link Belt Company, of Chicago, died Nov. 3, at his residence, 1165 Fifth Avenue, that city, in his 63rd year. He was a native of Boston. He was graduated from Massachusetts Institute of Technology in 1888. Throughout his career he was concerned with engineering enterprises. For 29 years he was with the Brown Hoisting Machinery Company of Cleveland.

CHARLES E. PATTISON, a partner of Pattison Brothers, consulting engineers, of New York City, died at his home in Montclair, N. J., Nov. 1, after a long illness. Mr. Pattison was born in New York in 1864 and was a member of the Association of Edison Pioneers.

PERSONALS

WILLIAM R. HINCHMAN, formerly assistant treasurer and assistant secretary of the American Water Works & Electric Company, has been elected treasurer of the West Penn Electric Company, and will be permanently located in Pittsburgh, Pa.

C. W. FOSTER, formerly district manager of the Swartout Company, at Chicago, Ill., has severed his connection with this company. He will personally take over a number of accounts in the sales engineering field in the same territory.

HARTLEY L. H. SMITH, superintendent of steam power, New England Power Company system, since 1918, and for the previous sixteen years chief of the testing bureau, Brooklyn Rapid

Transit Company, has been appointed research engineer of the New England Power Association, with headquarters in Boston, Mass.

L. R. BRECKENRIDGE, professor emeritus of mechanical engineering at the Sheffield Scientific School, Yale University, sailed for Italy on Nov. 3, on the S.S. *Conte Biancamano* of the Lloyd Sabaudo Line.

WILLIAM H. SNOW has resigned from the New Bedford Gas & Edison Light Company, of New Bedford, Mass.

GANO DUNN, president of the J. G. White Engineering Corporation, has recently been appointed an alumni trustee of Columbia University, New York City.

PAUL B. METCALF, formerly with the Narragansett Electric Company, Providence, R. I., is now connected with the New England Power Association at 89 Broad St., Boston, Mass.

GREGORY M. DEXTER has taken a position with Peabody, Smith & Co., Inc., of New York City and will be engaged in engineering investigations of properties for new financing purposes. He was formerly employed by the Honolulu Iron Works Company in its Eastern division offices in New York City.

A. F. HINRICHSEN, formerly vice-president of the Reed Engineering Company, Inc., has established A. F. Hinrichsen, Inc. The new organization will specialize in the sale of equipment for heating, ventilating and sanitation purposes.

SOCIETY NOTES

A.S.M.E.—Iron and Steel Division, Chicago, will hold a banquet and meeting at the Palmer House, Nov. 14, at 7 p.m. Prof. W. Trinks, of the Carnegie Institute of Technology, will give a talk on "Some Observations on European and American Steel Plants," and there will be other discussions on iron and steel subjects.

A.S.M.E. — CLEVELAND SECTION. Meeting on Nov. 16 at Carnegie Hall, Cleveland. Subject: "The Trend Toward High Temperature and High Compression Fuel for Automobiles," by J. S. Harrison, of the Standard Oil Company.

A.S.M.E.—Philadelphia Section. Meeting, Nov. 27. Subject: "Conowingo Hydro-Electric Development," by Alexander Wilson, 3rd, Assistant Chief Engineer, The Philadelphia Electric Company.

A.S.H. & V.E.—Massachusetts Chapter. There will be a meeting in Boston on Dec. 3, at which A. C. Willard, president of the society, will speak.

A.S.H. & V.E.—Council Meeting in New York City, Dec. 6, at 29 West 39th St. At this meeting the program of the annual meeting will be discussed.

ENGINEERS' CLUB OF ST. LOUIS—Meeting, Nov. 14. Lecture on "Welded Steel Buildings," by Prof. F. P. McKibben, General Electric Company.

BUSINESS NOTES

THE C. F. PEASE COMPANY, Chicago, Ill., announces that its New York sales office and display rooms have been moved to larger quarters on the twelfth floor of the Ashforth Bldg., 12 E. 44th St., New York City.

THE AMES IRON WORKS announces the removal of its Chicago office to the Transportation Bldg., 608 So. Dearborn St. The new office will be in the charge of Frank H. Pond.

THE E. KEELER COMPANY, of Williamsport, Pa., announces that its Philadelphia office has been moved from the Rush Bldg. to the Bulletin Bldg., that city. The new office will be in the charge of H. L. Peel and G. W. Crawford, sales engineers.

THE CONSOLIDATED ASHCROFT HANCOCK COMPANY, INC., announces the removal of its Chicago Office to 605 W. Washington Boulevard, effective Nov. 15. This office will house also the staff of the American Schaeffer & Budenberg Division, recently consolidated with the Ashcroft Hancock Company. G. A. Binz, formerly general sales manager of American Schaeffer & Budenberg Corporation, has been appointed sales manager in charge of the Western Industrial Division with headquarters in Chicago. The Western Division will handle the business of the company in all of that part of the United States and Canada west of a line drawn from Toronto, Ont., to New Orleans, La.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.35@$2.60
Kanawha.....	Columbus.....	1.35@ 1.75
Smokeless.....	Cincinnati.....	2.25
Smokeless.....	Chicago.....	2.25
S. E. Kentucky...	Chicago.....	1.35@ 1.60
Steam.....	Pittsburgh.....	1.65@ 1.80
Gas Slack.....	Pittsburgh.....	1.00@ 1.20
Big Seam.....	Birmingham....	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.00
Barley.....	New York.....	1.25@ 1.75

FUEL OIL

New York—Nov. 8, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis—Oct. 31, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.375 per bbl. or 42 gal.; 26@28 deg., $1.425 per bbl.; 28@30 deg., $1.475 per bbl.; 30@32 deg., $1.525 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5.25c. per gal.

Pittsburgh—Oct. 30, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5½c. per gal.

Philadelphia—Oct. 25, 26@30 deg., $1.89@$1.96 per bbl. or 42 gal.; 13@19 deg., $0.95@$1.02 per bbl.; 22 plus. $1.43@$1.50 per bbl.; 27@30 deg., $2.00@$2.07 per bbl.

Cincinnati—Nov. 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Nov. 5, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 97½c.@$1 per bbl.

Boston—Nov. 5, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.56c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—Oct. 27, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons.

TRADE CATALOGS

COMPRESSORS — The Chicago Pneumatic Tool Company, Chicago, Ill., has issued Bulletin No. 786, describing vertical duplex compressors. The bulletin contains eight pages and gives many of the salient points in connection with this product. It is fully illustrated.

RETURN TRAP—The Julian D'Este Company, of Boston, Mass., has issued a four-page bulletin discussing the Curtis Type T return trap, applicable to various uses around the power plant. A short description is given, together with several illustrations.

LUBRICATION—William W. Nugent & Company, Chicago, Ill., has recently issued a bound set of its recent bulletins dealing with oiling systems and filtering devices of all kinds. The collection is mainly pictorial, and in it are given many illustrations of applications of the devices mentioned.

PULVERIZED FIRING SYSTEM—The Kennedy-Van Saun Manufacturing and Engineering Corporation has just issued a six-page bulletin showing some of its pulverized fuel installations.

SPECIAL STEELS—The Southern Manganese Steel Company, St. Louis, Mo., has issued a small booklet giving a history and description of "Fahralloy," a series of special nickel-chromium alloys adapted to uses where heat and corrosion resistant properties are desirable.

LUBRICATORS — The American Oil Pump & Tank Company, Cincinnati, Ohio, has issued a new bulletin, No. 1160, setting forth its model F force feed lubricator, suitable for use on steam engines, compressors, etc. The publication contains eight pages, including a number of cuts and tables.

SURFACE TYPE COOLERS AND HEATERS —Bulletin 12-G, just issued by the Schutte & Koerting Company, Philadelphia, Pa., describes in twelve pages the action of various types of coolers and heaters for air and gases. An interesting feature of the publication is the use of sectional drawings in which the flow of the fluids is shown in various colors, so that the transition in pressure, temperature, etc., may easily be identified. There are also several charts showing the heat transfer in various pieces of apparatus.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Bakersfield—Atchison, Topeka & Santa Fe Ry. Co., 80 East Jackson Blvd., Chicago, Ill., awarded contract for the construction of an ice plant here to Robert E. McKee, 1128 Central Bldg., Los Angeles. Estimated cost $72,600. M. C. Blanchard, Amarillo, Tex., Ch. Engr. (Western Lines).

D. C., Washington—D. C. Commissioners will soon award contract for remodeling power plant at Galliger Hospital.

Ill., Chicago—L. S. Drive Corp., c/o R. S. De Goyler & Co., 307 North Michigan Ave., awarded contract for a 27 story apartment building to Turner Construction Co., 228 North La Salle St. Estimated cost $1,500,000.

Ill., Chicago—Illinois Steel Co., 8665 Burley St., will build a 92 x 202 ft. power station. Estimated cost $175,000.

Ky., Louisville—Jewish Hospital Association, Floyd and Kentucky Sts., awarded contract for additions to hospital and nurses' home including additional power facilities, etc., to H. A. Doll Co., 1114 Lexington Rd.

Me., Bingham—Central Maine Power Co., W. Wyman, Pres., Augusta, awarded contract for a power development including dam and power plant to M. C. Tuttle Co., 862 Park Sq. Bldg., Boston, Mass. Estimated cost $1,000,000.

Mo., St. Louis — Wagner Electric Co., 6400 Plymouth Bldg., is having preliminary plans prepared for the construction of a 1 story, 120 x 300 ft. transformer building and 3 story, 80 x 120 ft. manufacturing building. Estimated cost $250,000. Condron & Post, 53 West Jackson Blvd., are architects.

N. J., Bayonne—Bd. of Commissioners, City Hall, receive bids about Nov. 15, for a 4 story municipal building, including steam heating and ventilation systems, boilers, elevators, etc., at Ave. C between 27th and 28th Sts. Estimated cost $1,000,000. P. A. Vivarttas, 110 48th St., Union City, is architect.

N. J., Belleville — Bd. of Chosen Freeholders, Hall of Records, Market St. and Springfield Ave., Newark, will receive bids about Nov. 15 for the construction of an 8 story hospital, nurses' home, etc., including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc., at County Isolation grounds. Estimated cost $1,000,000. Sutton, Sutton & Calkins, 402 Broad St., Newark, are architects.

N. J., Bloomfield—Bloomfield Trust Co., Glenwood Ave., is having plans prepared for a 5 story bank and office building, including steam heating and ventilation systems, boilers, elevators, etc., at Broad St. and Bloomfield Ave. Estimated cost $1,000,000. Upfinder, Foster & Bookwalter, 221 West 57th St., New York, N. Y., are architects.

Okla., Britton—Zero Ice & Cold Storage Co., 729 West Grand St., Oklahoma City, plans the construction of a 20 ton ice plant here. Estimated cost $30,000. Private plans.

Pa., Ford City — Borough Council, will soon award contract for the construction of a waterworks system, including flood pumping station, pump pit, two 1,500 g.p.m. pumping units, etc. Douglas & McKnight, 912 Columbus Bank Bldg., Pittsburgh, are engineers.

Pa., McKeesport—Duquesne Light Co., 435 6th Ave., Pittsburgh, awarded contract for the construction of operating headquarters here, to W. F. Trimble & Sons, 1719 Pennsylvania Ave. Estimated cost $250,000.

Tenn., Memphis—City, E. V. Sheely, Acting Postmaster, awarded contract for addition to De Soto sub-station on Calhoun Ave. to Devault & Derrick Inc., Canton, O. Estimated cost $175,000.

Texas—Atlantic Pipe Line Co., 260 South Broad St., Philadelphia, Pa., will build eleven pumping stations, between Midland and Port Arthur on main line, also a large steel warehouse building at each station and 10,000 bbl. tank. Estimated cost $200,000. Private plans.

Tex., Dallas—Dallas Power & Light Co., Ind. Bldg., plans extensions and improvements to power plant. Estimated cost $2,500,000. Work will be done by owners' forces.

Tex., Donna—J. C. Engleman, plans the construction of two pumping stations and two reservoirs in connection with irrigation system. Estimated cost $80,000.

Tex., Raymondville—George R. Lochrie, plans the construction of a 40 ton ice plant. Estimated cost $50,000. Private plans.

Tex., San Antonio—San Antonio Public Service Co., E. H. Kifer, Mgr., will build a sub-station to include four transformers for carrying power to the Republic Portland Cement Co., now under construction, 12 miles north of San Antonio. Estimated cost $70,000. Private plans.

Tex., Skidmore — Pacific Fruit Express Co., c/o W. T. White, Asst. Gen. Mgr., Engr. and Refrig., Southern Pacific Bldg., 65 Market St., San Francisco, Calif., will soon award contract for additional facilities including 100 ton ice storage plant, unloading platform, incline, crossover and double retarding conveyor, etc., here. Private plans.

Tex., Winters—City plans an election Nov. 20 to vote $72,000 bonds for waterworks improvements, including pumping equipment, mains, etc. Estimated cost $72,000. J. S. Barlow is engineer.

Wash., Olympia—City plans an election Nov. 19 to vote $225,000 bonds for extensions and improvements to waterworks, including wells, pumps, motors, etc.

Wash., Woodland — Northwest Electric Co., L. T. Merwin, V. Pres. and Gen. Mgr., Pittock Bldg., Portland, Ore., is having plans prepared for the construction of a hydro-elecrtic power plant and dam, 230 ft. high on the Cowlitz River near here, to develop 60,000 hp. Estimated cost $5,000,000.

Ont., Meaford—Canadian Rail & Harbor Terminals, foot of York St., plans the construction of an electrically operated grain elevator, 1,000,000 bu. capacity to include conveying equipment. Estimated cost $500,000. C. D. Howe & Co., Whalen Bldg., Port Arthur, are architects.

Equipment Wanted

Air Compressor, etc.—W. H. Trowbridge, 170 Virginia Rd., Concord, Mass., is in the market for an air compressor for stone drilling, etc.

Engines, Pumps, etc.—Masden Farm Development Co., H. H. Masden, Pres., Big Wells, Tex., plans to purchase and install approximately 40 engines 20 to 30 hp. with equal number of pumps for proposed canning and pickling plant.

Pump—M. B. Beatty, County Clk., Los Angeles, Calif., will receive bids until Nov. 19 for a deep well turbine pump for Tract No. 4.

Pumps, etc.—City of Capreol, Cnt., plans to purchase pumps, etc., for proposed waterworks improvements. Estimated cost $90,000.

Pumping Equipment—City of Ann Arbor, Mich., pumping equipment for proposed extensions and improvements to waterworks. Estimated cost $500,000.

Pumping Units—Sanitary Dist. of Chicago, 910 South Michigan Ave., Chicago, Ill., will receive bids until Nov. 22 for three synchronous motor driven vertical shaft centrifugal pumping units, each 300 cu.ft. per second capacity and six synchronous motor driven vertical shaft centrifugal pumping units, each 600 cu.ft. per second capacity for Racine Ave. sewage pumping station.

Pump—Town of Blind River, Ont., M. L. Dyke, Clk., will receive bids until Nov. 21 for one 1,200 g.p.m. three stage engine driven centrifugal pump with accessories. $10,000.

Industrial Projects

Calif., Monterey — PACKING PLANT — Hovden Packing Co., Ocean View and David Sts., awarded contract for a 2 story packing plant, to Villadsen Bros., 417 Market St., San Francisco. Estimated cost $50,000.

Calif., Piru — PACKING PLANT — Piru Citrus Packing Co. is having plans prepared for a 1 story, 100 x 100 ft. packing plant. W. P. Sherherd, 15 South El Molino St., Pasadena, is architect.

Mich., Detroit—AUTOMOBILE ASSEMBLY PLANT—Dodge Bros., Div. Chrysler Motor Car Co., 341 Massachusetts Ave., Highland Park, is having plans prepared for a 1 story, 120 x 1,952 ft. plant on Mt. Elliott Ave. A. Kahn, 1000 Marquette Bldg., is architect. Owners in the market for steam heating, electric motors and assembly equipment.

Mich., Detroit—GEAR FACTORY—Detroit Gear & Machine Co., Woodbridge St., awarded contract for a 4 story, 70 x 150 ft. gear factory, to Stokes & Whittingham, Penobscot Bldg. Estimated cost $75,000. Gear cutting and finishing machine equipment will be installed.

Mich., Detroit—AUTOMOBILE POLISH PLANT—C. H. McAleer Mfg. Co., 4718 Burlingame Ave., awarded contract for a 1 and 2 story, 105 x 200 ft. factory on Lyndon Ave. to Max Bartholomaei Son & Co., 1574 East Warren Ave. Estimated cost $60,000.

Mich., Highland Park (Detroit P. O.) — TRUCK BODY PLANT—Wood Hydraulic Hoist & Body Co., 7924 Riopelle St., Detroit, awarded contract for a 1 story, 50 x 350 ft. truck body plant on Cardoni Ave., to Otto Randolph Inc., 53 West Jackson Blvd., Chicago, Ill. Estimated cost $55,000.

Mich., Lansing—MOTOR WHEEL FACTORY — Motor Wheel Corp., Saginaw St., awarded contract for a 1 story, 200 x 400 ft. wheel factory on Ferris St. to George Hagemeir, 216 West Lapeer St.

Mich., Pontiac—AUTOMOBILE PLANT ADDITION—Oakland Motor Car Co., Oakland Ave., plans the construction of a 2 story, 45 x 100 ft. addition to automobile plant. Estimated cost $50,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mo., Crystal City — GLASS PLANT — Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, Pa., is having plans prepared for a 2 story, 100 x 1,100 ft. addition to glass plant. Estimated cost $1,000,000. Private plans.

N. J., West New York — ELECTRIC LAMP FACTORY — Lockwood, Greene & Co., Inc., 100 East 42nd St., New York, N. Y., Archts. and Engrs., are receiving bids for a 3 story, 70 x 180 ft. factory at 11th St. and Schley Pl., for Brinkerhoff Electric Co., c/o architects and engineers. Estimated cost $75,000.

Okla., Oklahoma City — CONCRETE PIPE FACTORY — Independent Concrete Pipe Co., 201 North West St., Indianapolis, Ind., is having preliminary plans prepared for the construction of a concrete pipe factory at 12th and Pennsylvania Sts., here. Estimated cost $50,000. Private plans.

Texas—OIL REFINERIES—Texas Co., 17 Battery Pl., New York, N. Y., plans the construction of an oil refinery at Amarillo, 50,000 bbl. per month capacity, also at El Paso and San Antonio, 90,000 bbl. per month capacity. Estimated cost $125,000 to $250,000 each. Owners taking bids on pipe stills, agitators, weathering plants, steam stills, etc.

Ont., St. Catharines — DAIRY PRODUCTS PLANT — Silverwoods Ltd., A. E. Silverwood, Mgr., London, awarded contract for the construction of a 1 and 2 story dairy products plant on Welland Ave., here, to T. F. Jones, 167 Church St., St. Catharines. Estimated cost $75,000. Equipment for manufacturing dairy products, also refrigeration equipment will be required.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

A DECLINE of about $1.20 per 1,000 ft. in flexible cord, constitutes the principal price fluctuation since Oct. 9, in the accompanying list of electrical supplies. Babbitt metal (highest grade) declined 1c. per lb., during the last month, following a decrease of ½c. from the September level. Linseed oil, on the other hand, continues in its upward trend, while higher prices obtain in the market for white, wiping cloths.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply....$0.30	4 ply....$0.36

Steam—Discounts from List

First grade.....40%	Second grade.. ...45%	Third grade....50–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%
Second grade	60%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium grade	30–10%
Medium grade, heavy weight	30@5%

RAWHIDE LACING—For cut, best grade, 30@5%; 2nd grade, 45@5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c. Semi-tanned, cut, 30–5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ¼ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@$2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots of 250 to 2,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago	$0.17
New York	.16@.16½
Cleveland (*per thousand*)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.109	$0.11	$0.108

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-10% in ful packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ¾-in., per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill.....$2.90

Cone-head boiler rivets, ½-in., per 100 lb.:
New York..... $5.30* Chicago... $3.90 Pittsburgh mill.....$3.20

*Price is for full packages; broken package lots, $6.50 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	66.75
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3½	30.25	49.50	30.67
3¾	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2½ and 2¾ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$31.00 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	35%
1,000 to 5,000 ft.	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.: **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 4 per cent. additional.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
½	103.31	113.00	15.10	17.21	8.39	9.13
¾	139.77	152.88	20.51	23.07	11.78	12.75
1	167.12	182.79	27.34	30.76	14.56	15.75
1¼	224.85	245.94	50.13	56.40	19.41	21.01
1½	355.50	388.85	82.03	92.28	27.73	30.01
2	464.88	508.50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$16 50
No. 16 cotton reinforced heavy		20 00
No. 18 cotton reinforced light		13 00
No. 16 cotton reinforced light		17 60
No. 18 cotton Canvasite cord		14 60
No. 16 cotton Canvasite cord		16 90
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76 70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.75	$8.00	$9.75	$16.00
12	8.80	10.20	12.10	22.00
10	11.90	14.00	16.00	28.90
8	17.50	19.20	20.15	39.50
6	.....	.....	30.00	.....
4	.....	.....	42.00	.....
2	.....	.....	60.00	.....
1	.....	.....	82.00	.....
0	.....	.....	101.00	.....
00	.....	.....	119.00	.....
000	.....	.....	142.00	.....
0000	.....	.....	172.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots	29c per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots	31c per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Soldering paste, 2 oz. cans		$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30–5%
$50.00 list value or over	35%